AGRICULTURAL HAND INJURIES – A PROSPECTIVE DESCRIPTIVE STUDY

In partial fulfillment of the
regulations for the award of the degree of

MASTER OF CHIRURGIE

(M.Ch.,) Degree

BRANCH – III – PLASTIC SURGERY

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CERTIFICATE

This is to certify that this dissertation entitled **"AGRICULTURAL HAND INJURIES – A PROSPECTIVE DESCRIPTIVE STUDY"** submitted by **Dr.R.MANOHARAN,** post graduate, Department of Plastic & Reconstructive surgery, Thanjavur Medical College to The Tamilnadu **Dr.M.G.R. Medical University, Chennai,** in partial fulfillment of the requirement in the award of degree of **MASTER OF CHIRURGIE IN PLASTIC SURGERY, Branch–III,** for the **AUGUST 2012** examination is a bonafide research work carried out by him under our direct supervision and guidance during the years 2009 – 2012.

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DECLARATION

I solemnly declare that this dissertation **"AGRICULTURAL HAND INJURIES – A PROSPECTIVE DESCRIPTIVE STUDY"** was prepared by me under the able guidance and supervision of our PROFESSOR & HOD, Department of Plastic & reconstructive Surgery, Thanjavur Medical College between OCTOBER 2009 and FEBRUARY 2012.

This is submitted to the Tamil Nadu Dr.M.G.R. Medical University, Chennai, in partial fulfillment of the requirement for the award of MASTER OF CHIRURGIE, M.Ch., PLASTIC SURGERY, DEGREE Examination to be held in AUGUST 2012.

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CONTENTS

INTRODUCTION

The Rice Bowl of Tamilnadu, the land of Big Temple and other exquisite temples, the Cradle of Art and Culture, Thanjavur district has many such distinctions. It is known for its cultural excellence and agricultural prominence.

LOCATION AND GEOGRAPHICAL DETAILS

The District lies between 9° 50’ and 11° 25’northern latitude and 79° 50’ of eastern longitude. It has a geographical area of 3396.57 sq.kms[13]. It is bound on the north by Tiruchirapalli and Perambalur District, on the west by Tiruchirapalli District, on the south by Pudukottai District and on the east by Nagapattinam and Thiruvarur District and Bay of bengal. The district is essentially a deltaic terrian and greater part of it consists of an undulating plain bisected by the valley of Cauvery. The climate of the district is basically tropical and the district falls under the category of medium and high rainfall region with annual average rainfall of 1021mm. Major part of precipitation is received through North East Monsoon (October early December). The soils in the district range from the alluvial in Cauvery Delta to sandy soils in coastal areas .

POPULATION

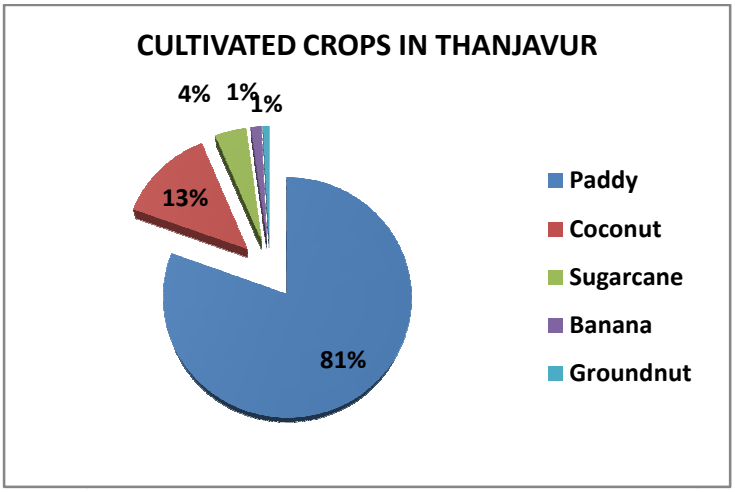
The total population of the district as per 2011 Census[25] is 24,02,781 and the male population is 11,83,112 and the female population is 12,19,669. Out of the total working population, agricultural labours constitute the largest group ie.8,32,621, indicating excessive occupational dependence on agriculture. The literacy rate is 82.2% comparatively lesser than the state average.

AGRICULTURE

Thanjavur District is The Rice Bowl of Tamil Nadu. As a result, most of the people in Thanjavur District are farmers. Many of these Farmers are tenant farmers, who work in the lands of a landlord and pay rent for their property. Major part of precipitation is received through North East Monsoon (October to early December). The soils in the district range from the alluvial in Cauvery Delta to sandy soils are coastal areas. . The major sources of irrigation are the canals (96%).Cauvery, Vennar and G.A. Canal contributes to the irrigation of the district.

TOTAL AREA OF CULTIVATION:

Irrigated lands 2,09,540.960 hectares, non irrigated lands 45,353,.950 hectares total 2,54,894.910 hectares[25]. Major crops cultivated in this study area are paddy (194,911 hec), coconut (31,749 hec), sugarcane (10,135 hec), banana (3,308 hec), and groundnut (1,831 hec). Paddy thrasher(around 140 units) , coir industries (25 units), and coconut industries (150 units) are running in this district.



PLACE OF IMPORTANCE:

Thanjavur is home to the famous BrahadeeshwaraTemple which was built by Raja Raja Chola during the 11th century. The Brahadeeshwara Temple, also known as the big temple, which is one of UNESCO[13] world Heritage sites. Among the other is the vijayanagar fort, and the Saraswathi Mahal library, which contains over 30,000 Indian and European manuscripts written on palm leaf and paper.

ECONOMY

Thanjavur economy is predominantly agrarian with about 75% of work depending on agriculture. Paddy is the principal crop which accounts for major portion of cropped area and the other crops are Sugarcane, Banana, Pulses and Oil-seeds. According to District Industries Centre, the district has got 8723 SSI units, 9 medium and large scale units, 5187 cottage industries and 7805 handicrafts units[25].

HEALTH INFRASTRUCTURE

In Thanjavur district the Government Head Quarter Hospital-1, taluk hospitals-6, Primary Health Centers - 58, Health Sub Centers - 309. One T.B. and chest disease's hospital[25] are functioning. Thanjavur Medical College Hospital, our institution, is the only referral center for the surrounding six districts. Our department is running hand clinic every Friday & providing emergency services round the clock throughout the year.

The hand plays an important role in almost every work of life. It is not only performs mechanical and prehensile functions also an important organ for expressions. Because of this, hand is the one organ having high risk to get injured and it is no surprise

that hand is the most common part of body to be affected by trauma[24]. Care of the human hand needs to take into account not only re creation of form but more importantly restoration of function

We received about 955 cases of hand injury cases in our study period. The third most common cause following RTA, Assault is Agricultural injuries. Persons working in the fields, agro industries are mostly of unskilled and low literacy . If they get injured they become economically dependent and burden to the family. Hence we have selected agricultural related hand injuries for our study.

AIMS AND OBJECTIVES

1. To study the pattern of injuries and epidemiological basis of Agricultural hand injuries in and around Thanjavur.
2. To study, and analyze the prognosis and recovery pattern of Agricultural hand injuries in terms of return to work following treatment.
3. To suggest measures for prevention of injuries.
4. Study Period – October 2009 – February 2012.

REVIEW OF LITERATURE

HISTORY OF HANDSURGERY

Susruta, the great Indian Surgeon is credited with describing the first pedicled flap in history. He is also described more than 120 surgical instruments, including scalpels, saws, scissors, needles, hooks, probes, directors, sounds, forceps, trocars, etc. Avicenna, an Arabian surgeon of the tenth century who advocated that cut or ruptured tendons should be sewn together.

Ambroise Pare (1510-1590) the father of modern surgery in 1536 described wound debridement and also reintroduced the use of a ligature. Pare is also developed prosthetic limbs for rehabilitation of amputees.

The invention of the microscope by Leeiivenhoek (1632-1723) laid the foundation for its future use in surgery. The invention of the operating microscope by Carl Zeiss[24] marked another breakthrough in the development of surgery. Nylen and Holmgren used the microscope for the first time in 1921for ear surgery. Jacobsen and Suarez in 1960 coined the word “micro-surgery” Malt and Mc Khann in 1962 successfully replanted an arm in a 12- year – old boy. Komatsu and Tamai reported the first successful replantation of a completely amputed thumb in 1965. Chinese surgeons, Chen Chun Wei, had actively involved in the development of microvascular anastomosis. Acland and Buncke in 1966, Buncke performed a toe- to - hand transfer in a rhesus monkey, the first human toe – to - thumb transfer by Cobbett in 1969. In 1972, of composite free tissue, a vascularised

omental transplant for a severe scalp avulsion in a young lady followed by Daniel and Taylor with a free skin flap transfer in 1973.

To repair tendons continued till the 19th century when Albrecht von haller refuted the Galenian concepts and obtained approval for tendon repairs of the French Academy of Science. Heuck reported the first successful free tendon graft in 1882 Codavilla towards the end of the 19th century wrote on tendon transfersand indicated the need for continuous motion to prevent adhesions. Sterling Bunnel (1882- 1957) the concepts such as asepsis, proper incisions, bloodless field, preservation of pulleys and timing of motion and therapy. Bunnel also developed a simple suture technique for tendons that was less bulky and permitted repair within the confines of the digital sheath. Bunnel coined the term "no man's land" for zone-II area. Verdan promote of the concept of primary repair in zone-II injuries. The late 1960s, when Kleinert and kutz from Loisville reported good results following primary repair in zone II injuries.

Nerve repair saw tremendous improvements in the latter half of the 20th century. The pioneering works of Sunderland on the internal topography of nerves and Seddon, who established standards for modern day nerve suture and grafting. Panas (1878) localized ulnar nerve compression to the elbow but it was only in 1887that the cubital tunnel was identified by Foux, who then went on to describe anterior transposition of the nerve for relief. Guyon described the tunnel that bears his name in 1861; it was Hunter in 1908 who described ulnar nerve compression in this location. Carpel tunnel release was reported only in 1933 by Larmonth, though the symptomatology of median nerve compression at the wrist had been described in 1880 by Putnam.

Duchenne (1872) who coined the term “obstetric palsy”. Erb in 1874 presented a classical description of an upper plexus lesion that now bears his name. Klumke, described her eponymous lower plexus palsy with Horner’s syndrome in 1875. The introduction of micro surgical techniques in plexus reconstruction by Millesi in 1964 and Narakas in 1966. Alain Gilbert from France has contributed significantly to the reconstruction and salvage of brachial plexus injuries.

Buck- Gramcko contributed to the reconstruction of the congenitally deformed hand and pollicization of the index finger in 1959.

BB Joshi from India who, constrained by cost concerns, developed an amazing array of splints using inexpensive household materials. James Hunter introduced the use of silicone Swanson developed silicone prostheses for almost all upper limb joints.

The development of hand surgery as a separate speciality began with Kanvel’s students Koch, Mason and Allen in Chicago as well as with Sterling Bunnel in SanFrancisco another towering personality was Eric MOberg of Sweden, who almost single handedly took hand surgery to the level of a new and separate speciality in Europe. Sterling Bunnel with Joseph Boyes led to the birth of the world’s first hand surgical society, American Society For Surgery of the Hand in 1946.The Japanes society which was. formed in 1957. International Federation of Societies for Surgery of the Hand was established in 1966.

ANATOMY

Our hands may be affected by many disorders, most commonly traumatic injury. For any physician or therapist treating hand problems, the mastery of hand anatomy is fundamental.

SKIN

The skin that covers the dorsum of the hand is greatly different from the skin that covers the palm. The skin of the dorsum of the hand is thin and pliable. It is attached to the hand's skeleton only by loose areolar tissue, where lymphatics and veins course. This fact explains why edema of the hand is manifested predominantly at the dorsum[4]. In addition, this loose attachment of skin makes the dorsum of the hand more vulnerable to skin avulsion injuries and also permits the creation of local flaps.

The skin of the palmar surface of the hand is unique, with characteristics for special function. The palmar skin is thick and glabrous[27] and not as pliable as the dorsal skin. It is strongly attached to the underlying fascia by numerous vertical fibers. These features enhance skin stability for proper grasping function.

The skin is most firmly anchored to the deep structures at the palmar creases; this is of clinical importance when planning surgical incisions, to minimize skin contractures. In contrast to the dorsal skin, the blood supply to the palmar skin is through numerous small, vertical branches from the common digital vessels. Therefore, the elevation of palmar skin flaps is limited. Finally, the skin of the palmar surface of the hand contains a high concentration of sensory nerve organs essential to the hand's normal function.

NAILS

The nails are specialized skin appendages derived from the epidermis. The nail bed has a germinal matrix, sterile matrix, and hyponychium. Ninety percent of the nail plate is produced by the germinal matrix, which approximately corresponds to the lunula. This germinal matrix starts proximally at the base of the distal phalanx just distal to the insertion of the extensor tendon. The sterile matrix is distal to the lunula[27]; it is very vascular, which accounts for the pink color and produces 10% of nail plate volume and adds squamous components, which make the nail stronger and adherent to the nail bed. The hyponychium is the distal part of the nail bed; its abundance of immune cells and adherence to the distal nail plate help the nail to resist infection.

The entire nail matrix is in intimate contact with the periosteum of the distal phalanx; therefore, it is vulnerable to injury when the latter is fractured.

PALMAR FASCIA AND DEEP COMPARTMENTS

The palmar fascia consists of resistant fibrous tissue arranged in longitudinal, transverse, oblique, and vertical fibers. The longitudinal fibers originate at the wrist from the palmaris longus tendon, when present. These fibers spread out to the base of each digit, where minor fibers extend distally and attach to tissues. This arrangement of fibers forms the fibrous flexor sheath and pulley system of each digit

The transverse fibers are concentrated in the mid palm and web spaces. They are closely associated with the longitudinal fibers and serve as pulleys[11] for the flexor

tendons proximal to the digital pulleys. The vertical fibers of the palmar fascia attach to the dermis of the palmar skin. Deep to the longitudinal and transverse fibers, the vertical fibers coalesce into septa and attach to the metacarpals, forming 8 different compartments for the flexor tendons and neurovascular bundles

A common central compartment is located proximal in the palm. The digits contain 2 fascial bands of clinical importance. These are the Grayson ligament and the Cleland ligament, which are located volar and dorsal to the neurovascular bundle of each digit, respectively. Knowledge of the anatomy of the palmar fascial fibers and deep compartments is crucial for identification of structures during procedures like palmar fasciectomy for Dupuytren disease.

NERVES

The hand is innervated by 3 nerves: the median, ulnar, and radial[11]. Each has sensory and motor components. Variations from the classic nerve distribution are so common that they are the rule rather than the exception The skin of the forearm is innervated medially by the medial antebrachial cutaneous nerve and laterally by the lateral antebrachial cutaneous nerve.

MEDIAN NERVE

The median nerve is responsible for innervating the muscles involved in the fine precision and pinch function of the hand. It originates from the lateral and medial cords of the brachial plexus (C5-T1). In the forearm, the motor branches supply the pronator teres, flexor carpi radialis, palmaris longus, and flexor digitorum superficialis muscles.

The anterior interosseus branch innervates the flexor pollicis longus, flexor digitorum profundus (index and long finger), and pronator quadratus muscles. Proximal to the wrist, the palmar cutaneous branch[27] provides sensation at the thenar eminence. As the median nerve passes through the carpal tunnel, the recurrent motor branch innervates the thenar muscles (abductor pollicis brevis, opponens pollicis, and superficial head of flexor pollicis brevis). It also innervates the index and long finger lumbrical muscles. Sensory digital branches provide sensation to the thumb, index, long, and radial side of the ring finger.

ULNAR NERVE

The ulnar nerve is responsible for innervating the muscles involved in the power grasping function of the hand. It originates at the medial cord[11] of the brachial plexus (C8-T1). Motor branches innervate the flexorcarpiulnaris and flexordigitorum profundus muscles to the ring and small fingers. Proximal to the wrist, the palmar cutaneous branch provides sensation at the hypothenar eminence. The dorsal branch, which branches from the main trunk at the distal forearm, provides sensation to the ulnar portion of the dorsum of the hand and small finger, and part of the ring finger.

At the hand, the superficial branch forms the digital nerves, which provide sensation at the small finger and ulnar aspect of the ring finger. The deep motor branch passes through the Guyon canal in company with the ulnar artery. It innervates the hypothenar muscles (abductor digiti minimi, opponens digiti minimi, flexor digiti minimi, and palmaris brevis), all interossei, the 2 ulnar lumbricals, the adductor pollicis, and the deep head of the flexor pollicis brevis.

RADIAL NERVE

The radial nerve is responsible for innervating the wrist extensors, which control the position of the hand and stabilize the fixed unit. It originates from the posterior cord of the brachial plexus(C6-8). At the elbow, motor branches innervate the brachioradialis and extensor carpi radialis longus muscles.

At the proximal forearm, the radial nerve divides into the superficial and deep branches. The deep posterior interosseous branch innervates all the muscles in the extensor compartment: supinator, extensor carpi radialis brevis, extensor digitorum communis, extensor digiti minimi, extensor carpi ulnaris, extensor indicis proprius, extensor pollicis longus, extensor pollicis brevis, and abductor pollicis longus.

The superficial branch provides sensation at the radial aspect of the dorsum of the hand, the dorsum of the thumb, and the dorsum of the index finger, long finger, and radial half of the ring finger proximal to the distal interphalangeal joints.

MUSCLES AND TENDONS

The muscles of the hand are divided into intrinsic and extrinsic groups. The intrinsic muscles are located within the hand itself, whereas the extrinsic muscles are located proximally in the forearm and insert to the hand skeleton by long tendons.

EXTRINSIC EXTENSORS

The extensor muscles are all extrinsic, except for the interosseous-lumbrical complex, which is involved in interphalangeal joint extension. All of the extrinsic

extensor muscles are innervated by the radial nerve. This group of muscles consists of 3 wrist extensors and a larger group of thumb and digit extensors.

The extensor carpi radialis brevis (ECRB) is the main extensor of the wrist, along with the extensor carpi radialis longus (ECRL) and extensor carpi ulnaris (ECU), which also deviate the wrist radially and ulnarly, respectively. The ECRB inserts at the base of the third metacarpal, while the ECRL and ECU insert at the base of the second and fifth metacarpal, respectively.

The extensor digitorum communis, extensor indicis proprius, and extensor digiti minimi extend the digits. They insert to the base of the middle phalanges as central slips and to the base of the distal phalanges as lateral bands. The abductor pollicis longus, extensor pollicis brevis, and extensor pollicis longus extend the thumb. They insert at the base of the thumb metacarpal, proximal phalanx, and distal phalanx, respectively. The extensor retinaculum prevents bowstringing of tendons at the wrist level and separates the tendons into 6 compartments

EXTRINSIC FLEXORS

The extrinsic flexors consist of 3 wrist flexors and a larger group of thumb and digit flexors. They are innervated by the median nerve, except for the flexor carpi ulnaris (FCU) and the flexor digitorum profundus to the small and ring finger, which are innervated by the ulnar nerve.

The flexor carpi radialis is the main flexor of the wrist, along with the flexor carpi ulnaris and the palmaris longus, which is absent in 15% of the population[2]. They insert at

the base of the third metacarpal, the base of the fifth metacarpal, and the palmar fascia, respectively. The FCU is primarily an ulnar deviator. The 8 digital flexors are divided in superficial and deep groups. Along with the flexor pollicis longus, which inserts at the thumb distal phalanx, they pass through the carpal tunnel to provide flexion at the interphalangeal joints. At the palm, the flexor digitorum superficialis tendon lies volar to the profundus tendon. It then splits at the level of the proximal phalanx and reunites dorsal to the profundus tendon to insert in the middle phalanx. The flexor digitorum profundus perforates the superficialis tendon to insert at the distal phalanx. The relationship of flexor tendons to the wrist joint, metacarpophalangeal joint, and interphalangeal joint is maintained by a retinacular or pulley system that prevents the bowstringing effect.

INTRINSICS

The intrinsic muscles are situated totally within the hand. They are divided into 4 groups: the thenar, hypothenar, lumbrical, and interossei muscles.

The thenar group consists of the abductor pollicis brevis, flexor pollicis brevis, opponens pollicis, and adductor pollicis muscles. All are innervated by the median nerve, except for the adductor pollicis and deep head of the flexor pollicis brevis, which are innervated by the ulnar nerve. They originate from the flexor retinaculum and carpal bones and insert at the thumb's proximal phalanx.

The hypothenar group consists of the palmaris brevis, abductor digiti minimi, flexor digiti minimi, and opponens digiti minimi. They are all innervated by the ulnar

nerve. This group of muscles originates at the flexor retinaculum and carpal bones and inserts at the base of the proximal phalanx of the small finger.

The lumbrical muscles contribute to the flexion of the metacarpophalangeal joints and to the extension of the interphalangeal joints. They originate from the flexor digitorum profundus tendons at the palm and insert on the radial aspect of the extensor tendons at the digits. The index and long finger lumbricals are innervated by the median nerve, and the small and ring finger lumbricals are innervated by the ulnar nerve.

The interossei group consists of 3 volar and 4 dorsal muscles, which are all innervated by the ulnar nerve. They originate at the metacarpals and form the lateral bands with the lumbricals. The dorsal interossei abduct the fingers, whereas the volar interossei adduct the fingers to the hand axis.

PULLEY

The pulley consists of transverse fascicular bands arising from the PA. The bands are approximately 1 cm in width, and the proximal edge of the pulley is 1-3 mm proximal to the origin of the membranous tendon sheath. The distal edge lies approximately 8-10 mm from the proximal edge of the first annular pulley. The PA pulley is anchored by vertical septa that attach to the deep transverse metacarpal ligament beneath the tendons. This pulley is not as closely applied to the surface of the flexor tendons as the annular and cruciate pulleys. However, during the act of grasping, increased tension on the palmar fascia by the flexor carpi ulnaris and palmaris longus muscles moves the pulley closer to the tendon surface.

ANNULAR PULLEYS

The 5 annular pulleys are as follows:

- A1 pulley - The first annular pulley arises from the palmar plate and proximal portion of the proximal phalanx, overlies the membranous sheath at the level of the MCP joint, and is approximately 8 mm in width; this pulley is released during surgical treatment of trigger finger (stenosing tenosynovitis)
- A2 pulley - The second annular pulley consists of oblique fibers that overlie annular fibers, originates from the proximal and lateral areas of the proximal phalanx, and is approximately 17 mm in width; this pulley should always be preserved when dealing with injuries to the retinacular system
- A3 pulley - The third annular pulley is located at the level of the PIP joint; it attaches to the palmar plate and is approximately 3 mm in width
- A4 pulley - Like the A2 pulley, the fourth annular pulley, located in the middle phalanx, also consists of oblique fibers overlying annular fibers and is always preserved during surgery of the retinacular system; the A4 pulley is approximately 6.7 mm in width and has been shown to be the most important biomechanical pulley for maintaining independent interphalangeal joint function
- A5 pulley - The fifth annular pulley is located proximal to the DIP joint, just proximal to the termination of the membranous sheath; the A5 pulley is the thinnest of the 5 annular pulleys and has a width of 4 mm

CRUCIFORM PULLEYS

The 3 cruciform pulleys are as follows:

- C1 pulley - The first cruciform pulley lies just distal to the A2 pulley
- C2 pulley - The second cruciform pulley is located in the space between the A3 and A4 pulleys
- C3 pulley - The third cruciform pulley is located distal to the A4 pulley; a number of anatomic variations have been described for the retinacular system

THUMB FLEXOR TENDON SHEATH

A separate flexor tendon sheath has been described for the thumb. The membranous portion of the sheath originates proximal to the radial styloid in the wrist and invests the single FPL tendon. The retinacular system consists of 3 separate pulleys overlying the membranous sheath, as follows:

- A1 pulley - The first annular pulley is located at the level of the MCP joint; it is approximately 9 mm wide and originates from the volar plate and base of the proximal phalanx
- Oblique pulley - This pulley overlies the sheath at the midportion of the proximal phalanx; the fibers of the pulley are angled obliquely in a proximal ulnar–to–distal radial direction, the pulley is 11 mm wide, and fibers from the adductor pollicis insertion make up the proximal portion (the oblique pulley is always preserved during surgery of the retinacular system)

- A2 pulley - The second annular pulley is 10 mm in width and attaches to the volar plate of the interphalangeal joint

BONES

A total of 27 bones[11] constitute the basic skeleton of the wrist and hand. These are grouped into carpals, metacarpals, and phalanges.

The wrist is the most complex joint in the body. It is formed by 8 carpal bones grouped in 2 rows with very restricted motion between them. From radial to ulnar, the proximal row consists of the scaphoid, lunate, triquetrum, and pisiform bones. In the same direction, the distal row consists of the trapezium, trapezoid, capitate, and hamate bones.

All carpal bones participate in wrist function except for the pisiform, which is a sesamoid bone through which the flexor carpi ulnaris tendon passes. The scaphoid serves as link between each row; therefore, it is vulnerable to fractures. The distal row of carpal bones is strongly attached to the base of the second and third metacarpals, forming a fixed unit. All other structures move in relation to this stable unit. The flexor retinaculum, which attaches to the pisiform and hook of hamate ulnarly and to the scaphoid and trapezium radially, forms the roof of the carpal tunnel.

The hand contains 5 metacarpal bones. Each metacarpal is characterized as having a base, a shaft, a neck, and a head. The first metacarpal bone (thumb) is the shortest and most mobile. It articulates proximally with the trapezium. The other 4 metacarpals articulate with the trapezoid, capitate, and hamate at the base. Each metacarpal head articulates distally with the proximal phalanges of each digit.

. Each digit contains 3 phalanges (proximal, middle, and distal), except for the thumb, which only has 2 phalanges.

JOINTS

The wrist joint is a complex, multiarticulated joint that allows wide range of motion in flexion, extension, circumduction, radial deviation, and ulnar deviation. The distal radioulnar joint allows pronation and supination of the hand as the radius rotates around the ulna. The radiocarpal joint includes the proximal carpal bones and the distal radius. The proximal row of carpals articulates with the radius and ulna to provide extension, flexion, ulnar deviation, and radial deviation. This joint is supported by an extrinsic set of strong palmar ligaments that arise from the radius and ulna. Dorsally, it is supported by the dorsal intercarpal ligament between the scaphoid and triquetrum and by the dorsal radiocarpal ligament.

At the intercarpal joints, motion between carpal bones is very restricted. These joints are supported by strong intrinsic ligaments. The 2 most important ones are the scapholunate ligament and the lunotriquetral ligament. Disruption of either one can result in wrist instability. The 3 Gilula lines have been described to represent the smooth contour of a greater arc formed by the proximal carpal bones and a lesser arc formed by the distal carpal bones in normal anatomy. All 4 distal carpal bones articulate with the metacarpals at the carpometacarpal (CMC) joints. The second and third CMC joints form a fixed unit, while the first CMC forms the most mobile joint.

At the metacarpophalangeal joints, lateral motion is limited by the collateral ligaments, which are actually lateral oblique in position, rather than true lateral. This

arrangement and the shape of the metacarpal head allow the ligaments to be tight when the joint is flexed and loose when extended (ie, cam effect)[27]. The volar plate is part of the joint capsule that attaches only to the proximal phalanx, allowing hyperextension. The volar plate is the site of insertion for the intermetacarpal ligaments. These ligaments restrict the separation of the metacarpal heads.

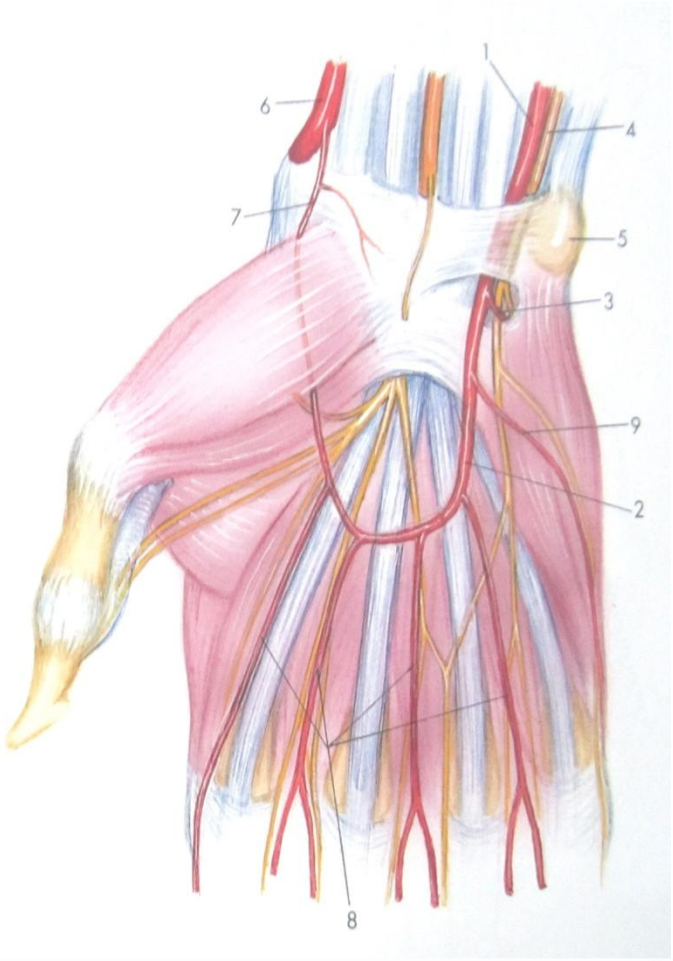
At the interphalangeal joints, extension is limited by the volar plate, which attaches to the phalanges at each side of the joint. Radial and ulnar motion is restricted by collateral ligaments, which remain tight through their whole range of motion. Knowledge of these configurations is of great importance when splinting a hand in order to avoid joint contractures.

BLOOD SUPPLY

The hand has a complex and rich vascular network. The radial and ulnar arteries, which are branches of the brachial artery[5], provide the blood supply to the hand. Supplemental arteries in the forearm include the anterior interosseous artery, the posterior interosseus artery, and (occasionally) the median artery, all of which are branches of the ulnar artery.

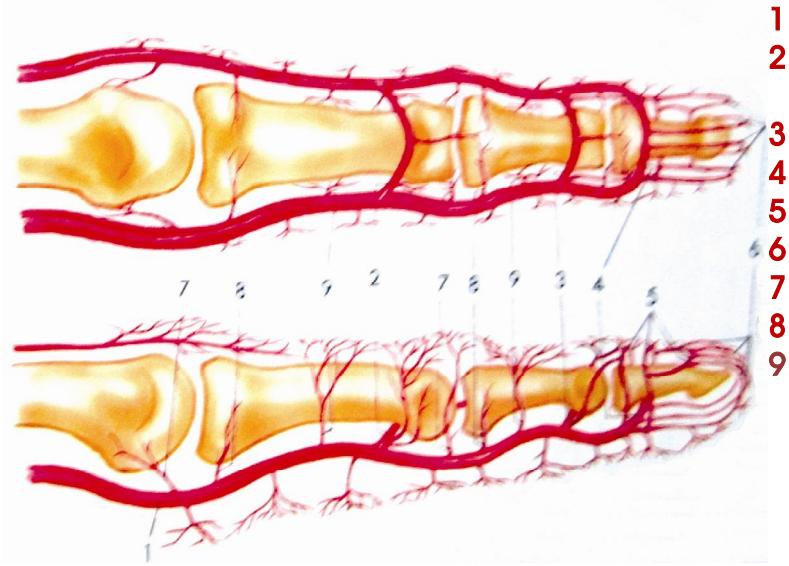
The radial artery runs distally in the forearm between the brachioradialis and flexor carpi radialis muscles. At the wrist, it crosses dorsally deep to the tendons of the "anatomic snuffbox" to enter the palm and form the deep palmar arch. A superficial branch arises at the level of the wrist and contributes to the superficial palmar arch. The ulnar artery runs distally in the forearm under the flexor carpi ulnaris muscle. At the wrist, it travels into the hand through the Guyon canal, where it divides into the deep

palmar branch and the superficial palmar branch. The superficial branch forms the superficial palmar arch, and the deep branch contributes to the deep palmar arch.



Blood supply of Hand

1. Ulnar artery
2. Superficial palmar arch
3. Deep branch of the ulnar artery
4. Ulnar nerve
5. Pisiform bone
6. Radial nerve
7. Superficial palmar branch of the radial artery.
8. Common palmar digital arteries.
9. Ulnar palmar digital artery of the little finger



1. Palmar digital artery
2. Proximal transverse palmar arch.
3. Middle transverse palmar arch
4. Distal transverse palmar arch
5. Matrix arches
6. Longitudinal arteries.
7. Condylar branch.
8. Metaphyseal branch.
9. Dorsal cutaneous branch

The superficial palmar arch lies directly deep to the palmar fascia. It gives rise to the volar common digital arteries and multiple branches to intrinsic muscles and skin. Distal in the palm, the common digital arteries bifurcate into the proper digital arteries. In the palm, the arteries lie volar to the corresponding nerves, a relation that is reversed in the digits. At the digits, the neurovascular bundle always lies volar to the ligament of Cleland. This pattern gives protection to the bundle and can serve as a guide for their surgical dissection.

The deep palmar arch[11] lies at the base of the metacarpals deep to the flexor tendons. It is the major blood supply to the thumb and radial half of the index finger by the first metacarpal artery. After giving its branch to the index finger, it is called the princeps pollicis.

The dorsal arteries originate proximally from the posterior interosseous artery and a dorsal perforating branch of the anterior interosseous artery[3]. Dorsal metacarpal arteries arise from a dorsal carpal arch formed by the previously mentioned arteries and are the source of multiple local hand flaps (dorsal metacarpal artery flaps). These dorsal metacarpal arteries are found more reliably for the first and second metacarpals then for the third and fourth.

Common digital arteries arise from the superficial palmar arch to form proper digital arteries at the webs. The palmar aspect of the digits receives arterial flow through these proper digital arteries. The dorsum of each digit, distal to the proximal interphalangeal joint, is vascularized by dorsal branches of the proper digital arteries.Veins generally follow the deep arterial system as venae comitantes. A

superficial venous system also exists at the dorsum of the hand and contributes to the cephalic and basilic vein in the upper extremity

FLEXOR TENDON INJURIES

- Restoration of satisfactory digital function after flexor tendon lacerations remains one of the most challenging problems in hand surgery
- Prior to the 1960's tendons lacerated in "no man's land" were not repaired in favor of delayed grafting
- Kleinert[5] and Verdan (1960's) showed superior results with primary repair leading to general acceptance of this approach

TENDON MORPHOLOGY

- 70% collagen (Type I)[5] , chondrocytes are the main componants
- Extracellular components
- Elastin
- Mucopolysaccharides (enhance water-binding capability)
- Endotenon – around collagen bundles
- Epitenon – covers surface of tendon
- Paratenon – visceral/parietal adventitia surrounding tendons in hand Synovial like fluid environment

Extrinsic Flexors

Superficial group: PT, FCR, FCU, PL Arise from medial epicondyle, MCL, and coronoid process

FDS: Arises from medial epicondyle, UCL, coronoid process Usually have independent musculotendinous origins and act independantly

Deep group FPL – originates from entire medial third of volar radius FDP – originates from proximal two thirds of the ulna, often has common musculotendinous origins

Carpal tunnel 9 tendons and Median nerve passes through this tunnel

Flexor sheaths: Present upto distal palmar crease

Predictable annular pulley, circular pulley arrangement.Gives Protective housing,Gliding surface,Biomechanical advantage

Surrounding Synovial layers merge at MP level. Flexor tendons weakly attached to sheath by vinculae camper's Chiasma

Tendon Nutrition

Vascular

- Longitudinal vessels Enter in palm at proximal synovial fold Segmental branches from digital arteries Long and short vinculae vessels at osseous insertions.

Synovial fluid diffusion

- Imbibition (pumping) of synovial fluid

Biomechanics

Efficiency of flexor system = the degree to which tendon excursion and muscle contraction translates into joint motion.Governed by integrity of the pulley system and resistance to glide

A2 and A4 most significant pulleys Pulleys decrease the moment arm length at each joint leading to increased joint motion

Tendon Healing

- Inflammatory phase (0-5 d); fibroblastic phase (5d – 6wks); remodelling (6wks-9mos)
- Intrinsic vs extrinsic healing
- Balance between the two determines amount of extrinsic adhesion vs intrinsic tendon healing

Tendon Adhesion

Increased adhesion formation with: Traumatic/surgical injury Crush injuries Ischemia due to disruption of vinculae

- Immobilization
- Gapping at repair site
- Excision/injury to flexor sheath components

Experimental attempts to minimize adhesion formation

Oral: steroids, antihistamines, NSAIDS

Topical: beta-aminoproprionitrile, hydrocyprolins, hyaluronic acid, collagen solutions, fibrin

Physical: silicone/cellophane wrapping, polyethylene tubes, interposed sheath flaps

Varying lab success but none proven definitively or adopted into clinical practice

"It now seems irrefutable that the most effective method of returning strength and excursion to repaired tendons involves the use of strong, gap resistant suture techniques followed by the frquent application of controlled motion stress" -Strickland

Zones of Injury[2]:

Zone – I: Distal to FDS insertion

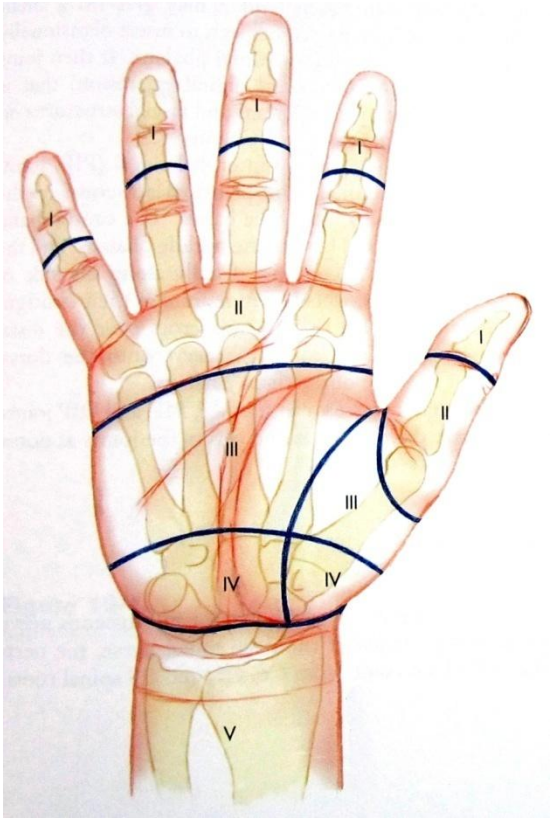
Zone - II: From the FDS insertion to the proximal edge of the AI pulley.

Zone – III: Between the distal edge of the transverse carpal ligament and the proximal edge of the fibro osseous canal[27].

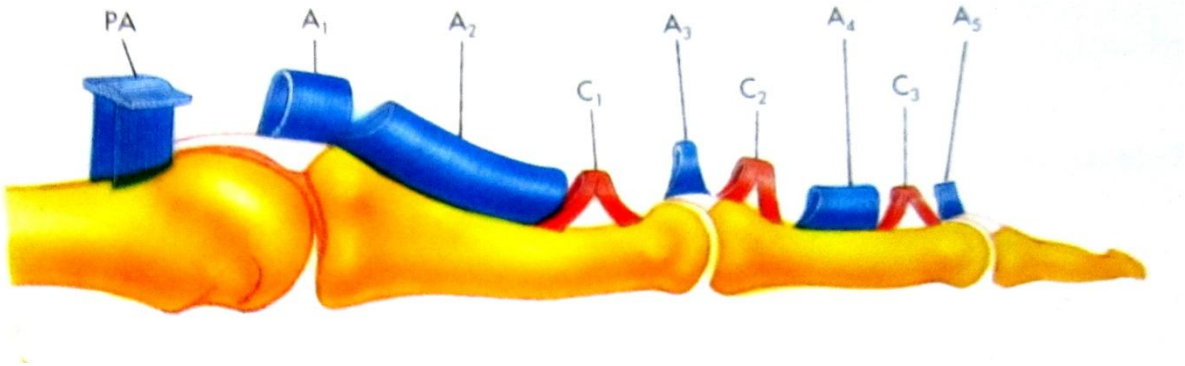
Zone – IV: Lies deep to the transverse carpal ligament.

Zone – V: Is proximal to the carpal tunnel and includes the forearm tendons and corresponding muscle bellies.

ANATOMIC ZONES FOR FLEXOR TENDONS



PULLEY SYSTEM



THUMB

Zone – T I: Is distal to the interphalangeal joint .

Zone – T II: Runs from the proximal edge of the AI pulley to the interphalangeal joint.

Zone – TIII: Is the region of the thenar eminence.

Zone – T IV: Is deep to the transverse carpal ligament.

Zone – T V: Is proximal to it.

Flexor Tendon Repair

Timing: Acute or subacute acceptable within 24 hours. Tendon deterioration/shortening after several weeks. Delay several days if wound infected

Incisions: Avoid crossing joint at 90 deg .Preference to use existing lacerations. Need to expose other structure, Zig zag incisions are the choice

Tendon Retrieval: Avoid trauma to synovial sheath lining Forceps/hemostat/skin hook if proximal stump is visible, proximal to distal milking, reverse esmarch are also useful techniques.

Suction catheter[27] is Sutured to proximal tendons in palm and deliver distally. Retraction often limited to A1/A2 pulley region by vinculae. If lacerated proximal to vinculae or if vinculae disrupted, tendon ends may retract into plam.

If proximal stumps have retracted into the palm the correct orientation of FDS and FDP must be re-established (such that FDP lies volar to Camper's Chiasm)

Repair Techniques

- Ideal
- Gap resistant
- Strong enough to tolerate forces generated by early controlled active motion protocols
- 10-50% decrease in repair strength from day 5-21 post repair in immobilized tendons
- This effect is minimized (possibly eliminated) through application of early motion stress
- Uncomplicated
- Minimal bulk
- Minimal interference with tendon vascularity

Core Sutures

- Current literature supports several conclusions regarding core sutures
- Strength proportional to number of strands
- Locking loops increase strength but may collapse and lead to gapping
- Knots should be outside repair site
- Increased suture caliber = increases strength
- 4-0 probably best suture material
- Dorsally placed suture stronger and biomechanically advantageous
- Equal tension across all strands

Partial Lacerations: Controversy in past as partial lacerations[5] were felt to predispose to entrapment, triggering and rupture, Repair if > 50% some advocate repair of partial lacerations > 60%

Tendon Advancement

- Previously advocated for zone 1 repairs, as moving the repair site out of the sheath was felt to decrease adhesion formation Disadvantages are shortening of flexor system Contracture, Quadregia effect, Little excursion distally, therefore adhesions near insertion less of an issue
- Strong gap resistant repair
- 4 strand, locking epitendinous (or equivalent), 4-0 suture needed for early active motion
- 4-0 suture, modified Kessler, running epitendinous (coaptation) suture adequate for more conservative protocols
- No sheath repair
- Large grasping/locking loops

Rehabilitation

Bunnel (1918)

- Postoperative immobilization
- Active motion beginning at 3 wks postop.
- Suboptimal results by today's standards

- Improved suture material/technique as well as postoperative rehabilitation protocols

Kleinert (1950s)

- Posterior splint, wrist in flexion
- Rubber bands from fingernails to volar wrist area hold fingers in flexion
- Patient able to actively extend against rubber bands (within confines of splint)
- Fingers pulled passively back into flexion
- Used widely since with some modifications
- Showed superior results with primary repair vs delayed grafting

Tendon excursion

- MP motion = no flexor tendon excursion
- 1.5 mm of excursion per 10 degrees of joint motion for DIP (FDP), PIP (FDS, FDP)
- These values decrease after repair by approx. 65% (DIP motion) &10% (PIP motion)

Splints

- Improved excursion with "palmar bar"[27] modification of Kleinert splint[5]
- Improved differential FDS/FDP excursion with Mayo clinic "synergistic" dynamic tenodesis splint
- Improved excursion with wrist extension (45 degrees)
- MP's at 90 degrees, IP's in extension when at rest
- Decreased tension at repair with wrist extension (45^{o})and MP flexion (90^{o})
- Distal palmar bar modification of Kleinert type splint

Mobilization Protocols

- Active extension with rubber band flexion
    - Eg. Kleinert splint, usually modified with wrist extension, MP flexion (90 degrees) and palmar bar to improve digital flexion
- Controlled passive motion
    - Posterior splint applied post-op
    - Controlled passive motion at regular intervals
- Controlled active motion
    - Proponents believe that excursion with passive protocols is generally poor compared to that achieved with light active motion
    - Therefore fewer adhesions and improved outcome
    - Risk: tendon rupture
    - Published rupture rates similar to those with passive protocols
    - 4 and 6 strand repairs with strong epitendinous suture

Wrist extension and MP flexion

- Many studies have described various protocols for early protected passive and active motion
- Results are almost always superior to previous more conservative protocols

Pulley Reconstruction

- Pulley loss

- Bowstringing = tendon taking shortest distance between remaining pulleys
- Biomechanical disadvantage is Excursion translates into less joint motion
- Adhesions/rupture at remaining pulleys due to increased stressA2 and A4 needed (minimum) Most biomechanically important
- some authors advocate reconstructing a 3 or 4 pulley system for optimal results
- Most done in conjunction with a two stage tendon reconstruction
- Can be done with single stage tendon graft
- generally if extensive pulley reconstruction is required it is better to do a two stage procedure

Methods

- Superficialis tendon
    - ❖ Insertion left intact
    - ❖ Remnant sutured to original pulley rim, to periosteum, or to bone through drill holes
- Tendon graft
    - ❖ Sutured as above
    - ❖ Passed through hole drilled in phalanx (risk of fracture)
    - ❖ Wrapped around phalanx (requires 6-8 cm of graft)
- Extensor retinaculum
    - ❖ Excellent gliding surface

- ❖ Difficult to harvest the 6-8 cm required for fixation around phalanx

- Artificial materials

  - ❖ Dacron, PTFE, nylon silicone

Tenolysis

- Release of nongliding adhesions for salvage in poorly functioning digits with previous tendon injury
- Avoid in marginal digits
- May not tolerate additional vascular/neurologic injury
- May need concomitant collateral ligament release, capsulotomy[5]
- Prepare patient for possible staged reconstruction

- Timing

  - o 3-6 mos. Post repair (minimum)

  - o Plateau with physiotherapy

- Anesthesia

  - o Local with sedation
  - o Allows patient participation
  - o Tests adequacy of release
  - o Motivates patient

- Technique

- Zig zag incisions
- Adhesions divided maintaining non-limiting adhesions
- Pulleys reconstructed as needed
- If extensive or not possible convert to staged reconstruction
- Immediate motion post operatively.

OUTCOME EVALUATION,

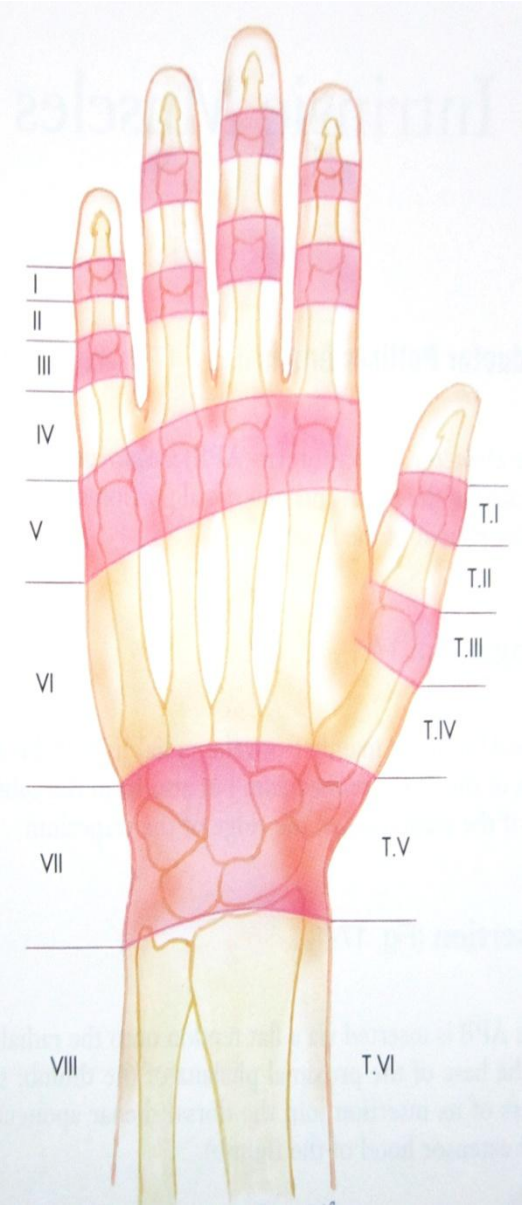
BOYES' METHOD : finger tip to distal palmar crease ;$< 1cm$: good, 1-2cm acceptable, $> 2cm\ is$ poor.

AMERICAN SOCIETY FOR SURGERY OF THE HAND SYSTEM

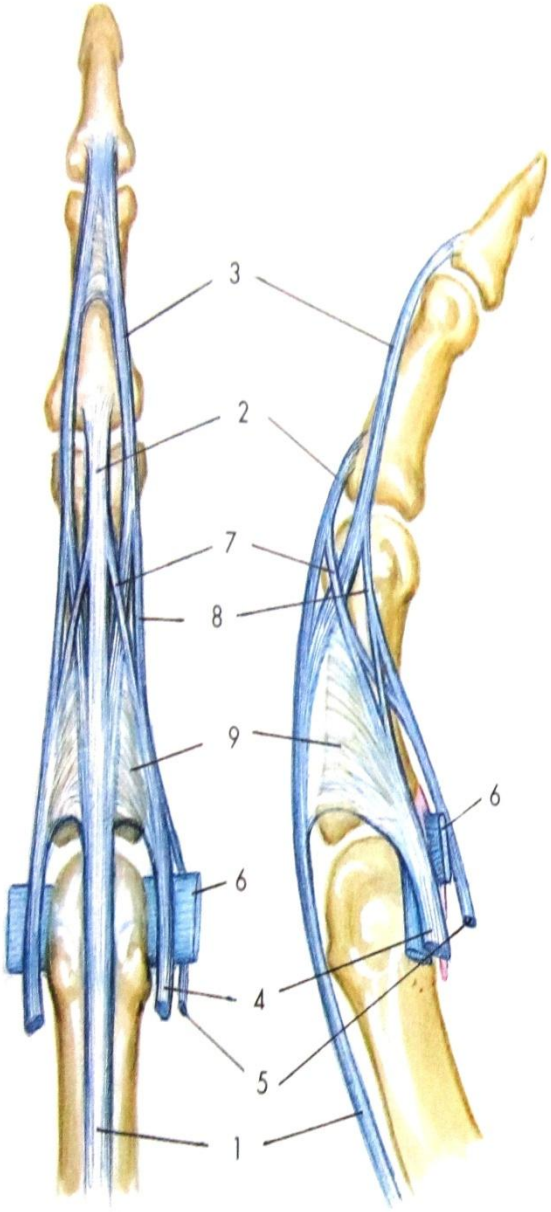
(MP+PIP+DIP) flexion- extension LAG=TAM (total activated motion)

EXTENSOR TENDON LACERATIONS

Extensor tendon lacerations of the hand and fingers are quite common constellations of injuries. Extensor tendon injuries can be grouped into 2 large categories: 1) acute simple laceration and 2) complex extensor tendon laceration with associated fractures, surrounding structures (eg, mallet finger, boutonniere deformity, sagittal band disorder.



THE EXTENSOR TENDON ZONES



EXTENSOR APARATUS

1. Extensor tendon
2. Central band of the extensor tendon
3. Collateral band of the extensor tendon
4. Interosseous tendon
5. Lumbrical tendon
6. Deep transverse metacarpal ligament
7. Medial band of the intrinsic tendons
8. Lateral band of the intrinsic tendons
9. Arciform fibers.

CLASSIFICATION OF EXTENSOR INJURIES & TREATMENT[2]

ZONE	FINGER	THUMB
I	DIP joint	IP joint
II	Middle Phalanx	Proximal Phalanx
III	PIP joint	MP joint
IV	Proximal Phalanx	Metacarpal
V	MP joint	CMC joint
VI	Metacarpal	
VII	Dorsal retinaculum	Dorsal retinaculum
VIII	Distal forearm	Distal forearm
IX	Proximal forearm	Proximal forearm

ZONE - I: (Mallet finger) rupture of terminal slip at DIP. Loss of active extension,with compensatory hyperextension of PIP result in swan neck deformity. closed and open methods used for treatment

Closed Method: With immobilization of DIP in extension 6 weeks- followed by 2 to 6 weeks night splinting

Open Method: Open Injury, fracture with large dorsal fragment treated with mattress sutures with 5 ‘0 prolene, (DOYTES) pull out suture with volar bolster , K wire fixation.

Chronic Injury: 1) 6-8 weeks splinting 2). Tendon repair 4-6 weeks pinning & splinting 6 to 8 weeks.3). Swan Neck deformity. Central slip tenotomy6

ZONE – II: MIDDLE PHALANX LEVEL

Exploration & repair of tendon with 5' 0 prolene running stitches.

ZONE – III Forced flexion or direct blow over DIP joint causes central slip injury. Boutonniere deformity: Flexion at PIP joint, extension at DIP in acute cases. In late cases . Palmar subluxation of lateral band leads to hyper extension of DIP.

Closed uncomplicated injury – Extensor splint. Open injury- Tendon repair- 1.) Aiche's repair with lateral band 2). Snow's repair with proximal slip

ZONE - IV: PARTIAL TENDON INJURIES ARE MORE COMMON.

Surgical exploration to assess the injury & repair if > 40% loss. Laceration associated with fracture PPX needs Kwire fixation or Plate & screw fixation.

ZONE – V: Clenched first or fight bite deformity. Joint capsule opened.

Human bite: May need delayed repair. Up to 7-10 days till infection settles. Sagital band injuries result in MCP joint instability to be treated with surgical repair.

ZONE – VI: All 4 EDC, EIP, EPL, EDM.

Possible to do tendon repair with modified kessler's technique. Splinting 4 to 6 weeks wrist in 30° extension, MCP 0° and IP joints free.

ZONE - VII: Usually due to penetrating trauma, retinaculum injured with tendons always. Repair of tendons and retinaculum to prevent Bowstringing of tendons, wrist extension 20°, MCP 0° ,IP joints free.

ZONE – VIII: Distal, 1/3 rd of forearm: (musculotendinous junction to proximal retinaculam). Tendons arranged in deep layer (APL, EPB, EPL, EIP) & superficial layer (EDC, ECRL, ECRB, ECU). After repair cock up splint for 4- 6 weeks.

ZONE - IX: Muscle Bellies are the components - Nerve,& vascular injuries to be ruled out in penetrating injuries. Muscle repair with 3'0 vicryl horizontal mattress. 4 weeks immobilization after this active mobilization with night splint to 3 weeks. Combined active and passive mobilization in both VIII and IX zone from eight weeks.

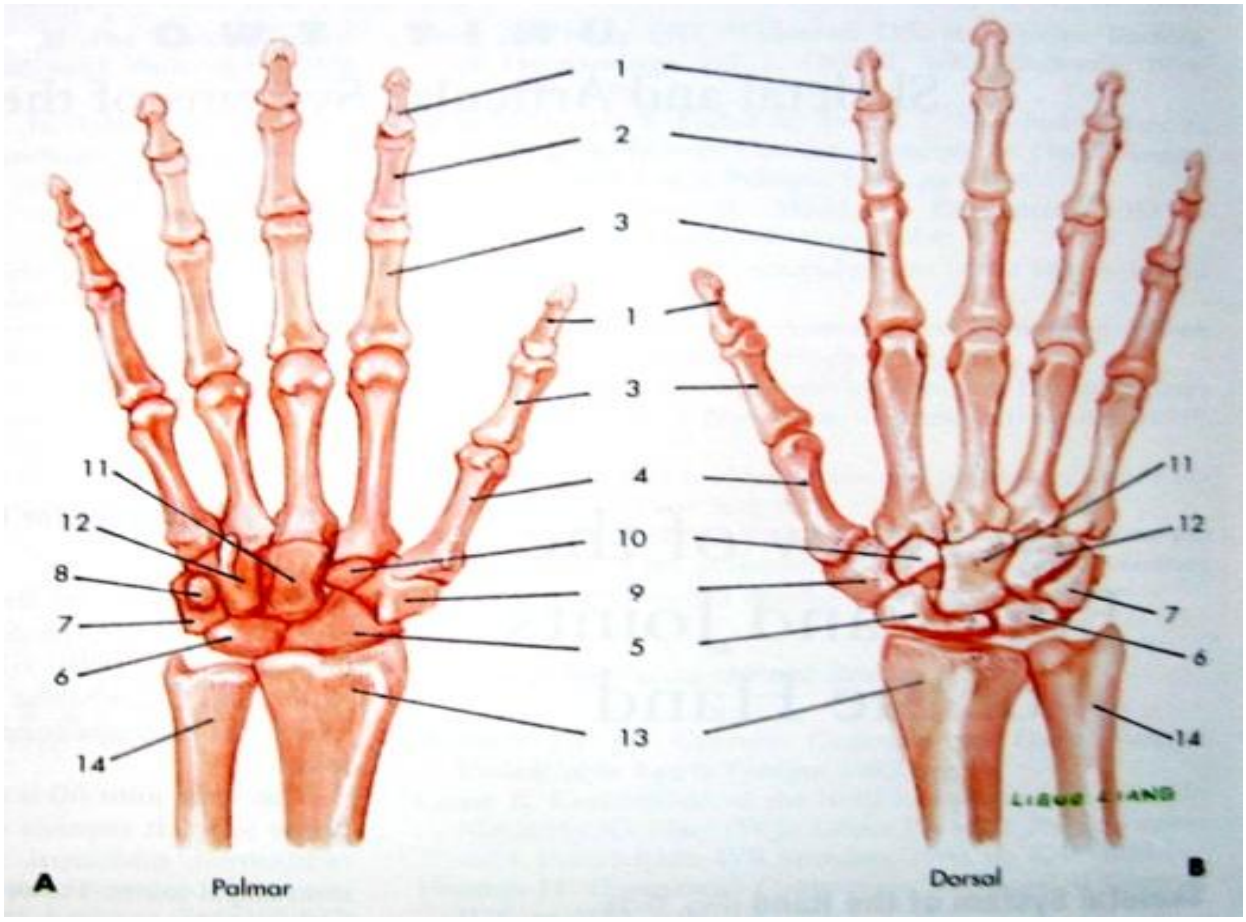
EXPECTED OUTCOME

TAM average 230° in 64 % without associated fracture dislocation. 45% had TAM average of 212° in associated fractures. Zone I to IV have more chances of adhesion.

PHALANGEAL FRACTURES

Pathophysiology

Stability of phalangeal fractures depends on location, fracture orientation, integrity of the periosteal sleeve, and degree of initial displacement. Distal tuft fractures are usually stable despite comminution. Unicondylar and bicondylar fractures involving the interphalangeal joints are inherently unstable. Displaced fractures involving the diaphyses of the proximal and middle phalanges are also unstable secondary to the pull of the intrinsics and flexor tendons. Fractures with an intact periosteal sleeve and no initial displacement are usually stable.



Skeletal System of the hand

A. Digital Bones.

1. Distal phalanx
2. Middle Phalanx
3. Proximal Phalanx
4. Metacarpals

B. Wrist bones.

5. Scaphoid
6. Lunate
7. Triquetrum
8. Pisiform
9. Trapezium
10. Trapezoid
11. Capitate
12. Hamate
13. Distal end of radius
14. Distal end of ulna

Distal Phalanx :

1. Tuft fracture (a) simple (b) comminuted
2. Shaft fracture, Transverse (- stable and unstable,) Longitudinal
3. Articular fracture – Volar- FDP, avulsion
    - Dorsal- mallet fracture
    - Epiphyseal

Tuft fractures are mostly comminuted fractures associated with soft tissue injury

Treated with PSS and 3 weeks immobilization

Shaft fractures – Nondisplaced fractures, P.S.S. Displaced fractures– K wire fixation and volar splinting for 4 to 6 weeks followed by active and passive mobilization

Epiphyseal fracture caused by hyperflexion

Middle and Proximal Phalanges fracture (WEISS-HASTINGS CLASSIFICATIONS)[5].

Condylar fracture 1.Oblique volar 2. Longitudinal 3. Dorsal coronal 4. Volar coronal They are mostly unstable and need internal fixation.

Neck fracture: common in toddlers crush injuries in the door with attempting to violent removal. Displaced fractures need axial K wire through DPx, DIP, head and body of MPx

Undisplaced fracture treated with Buddy splinting, volar splint for 3 weeks immobilization followed by mobilization.

Shaft fracture - Classified in to Tranverse, oblique, spiral, and comminuted fracture.

Closed fractures reduced and treated with immobilization splint 4-6 weeks.

Extensively comminuted fracture usually associated with soft tissue injuries so they managed conservatively.14 days immobilization followed by mobilization of MCP & IP joints.

Thumb Fracture:

Phalanx : 1. Tuft, 2. Shaft, 3. Articular - fractures

Tuft : Nailplate injury & subungual haematoma are common.P.S.S and splinting needed.

Shaft: 'K' wire pinning for transverse fracture and Longitudinal fracture treated with P.S.S, and splinting.

Avulsion Fractures of Articular Surface

1. Dorsum – Mallet thumb

2. Volar lip avulsion of FPL

3. Comminuted fractures usually due to direct trauma over IP , MCP. Treated conservatively for 30° flexion in joints itself good functional out come. Extension splinting for 6-8 weeks is needed.

Avulsion fracture: Base of PPX of ulnar borders. Goal keeper's or Skier's thumb More than 2 mm displacement needed 'K' wire pinning (or) lag screw fixation, 4-6 weeks immobilisation needed.

Metacarpal fracture:

Head fracture: are rare, displaced intra articular fracture due to direct trauma need fixation.

Shaft fracture: are uncommon.

Base fracture: Transverse or oblique.Fragments angulated with apex to dorsum. Closed reduction is stable. Immobilisation for 4-6 weeks. If unstable, 'k' wire pinning in extension is needed.

Intra articular: 1. Bennet's fracture[6]

2. Rolando's fracture

3. Comminuted CMC fracture

Bennet's fracture: If the fragment is <15-20% of articulates surface, closed reduction and percutaneous pinning of CMC joint with 'K' wire. If fragment is >25 to 30% ORIF to be done through wagner (L shaped) incision. 2.0-2.7 mm lag screw for ORIF. Alternatively with 2 pins used for fixation.

Immobilization for 4 weeks in cost. After pin removal, mobilsed

In lag screw fixation Joints mobilized after 10 days post operatively.

Rolando's fracture: Y or T shaped intra articular fracture at thumb base. Reduction is done with 'K' wire and ' T' plate is used for fixation 2.4 – 2.7.

Comminuted Fractures: Internal fixation is not possible. 1. Oblique transfusion of thumb metacarpal base through 'K' wire.

2. Budhlers quadrilateral external fixation, articular reduction with K wire.

3. Angular bone grafting if bone loss is present in MC.

Metacarpal fracture:

Meta carpo phalangeal fracture are the most common fracture of upper extrimities .More than 10 % of all fractures. These fractures are divided in to closed and open fractures. Closed, undisplaced, stable fractures and managed by splinting and immobilization 4-6 weeks.

INDICATIONS[27] FOR FIXATION OF METACARPAL AND PHALANGEAL FRACTURE:

Irreducible fractures

Malrotation (spiral and short oblique)

Intra – articular fractures (Phalangeal)

Open fractures

Segmental bone loss

Polytrauma with hand fractures

Multiple hand or wrist fractures

Fractures with soft tissue injury (vessel, tendon, nerve, skin)

Reconstruction (osteotomy)

The goal of fracture management is full and rapid restoration of hand function.

METACARPAL FRACTURES are divided in to Head, Neck, Shaft, Base and articular fractures.

Head fractures: They are rare and intra articular, axial loading and direct trauma are the main causes. Index finger is most commonly affected. Avulsion fractures at the origin of the collateral ligaments are caused by forced deviation of the flexed metacarpophalangeal joint. Two part coronal, sagital, oblique, Two part fractures treated with internal fixation by K wire lag screw. Comminuted fractures treated with immobilization for 2 weeks followed by aggressive motion exercise skeletal traction, external fixation, silicone arthro plasty, are other options.

Metacarpal shaft and neck injuries: metacarpal shaft fractures are produced by either axial loading or direct trauma. Torsional forces on the digits may also produce these injuries. Metacarpal neck fractures, the most common metacarpal fractures, usually result from striking a solid object with a clenched fist. Most common in ring and small finger (Boxer's fracture). Dorsal angulation occurs usually. In F2, F3 10 to 20°,in F4,F5-20to 30

angulation acceptable. Jahss maneuver for closed reduction followed by immobilizationin splint for 2 weeks.(wrist in 30° MCP 70° flexion) 4 weeks night splinting.

Shaft fractures may be transverse, oblique, spiral, comminuted fractures . Dorsal angulation is common. More than 20 in F2, F3, more than 30 in F4, F5, rotation deformity, shortening of length due to bone loss are the indications for ORIF. Cross K wire for Neck and Shaft fixation, percutaneous transverse pinning for Head and Shaft. Plate and screw fixation for Neck and shaft fracture. External fixation for comminution or bone loss. Lag screw for spiral fractures

Fractures and dislocations of the metacarpal base

Impaction fractures of the metacarpal bases that are not significantly displaced can be treated with splinting, followed by early mobilization. CMC dislocations and fracture-dislocations, especially when multiple, are unstable injuries need reduction with the addition of internal fixation. Displaced fracture-dislocations of the 4th and 5th metacarpals, which are accompanied by fracture of the dorsal hamate, require ORIF. Reverse Bennett fractures frequently need K-wire stabilization to counteract the deforming forces. If little articular incongruity is present, this may be a closed procedure.

PERIPHERAL NERVE INJURIES

Sedan Classification:-

1. Neuroproxia
2. Axonotmesis
3. Neurotmesis

Sunderland[24] classification:

1. Neuroproxia
2. Axonotmesis1
3. Axonotmesis 2
4. Neurotmesis 1
5. Neurotmesis2
6. Neuromo in continuity

First degree: Only Physiological distruption in nerve no anatomical or degenerative changes .

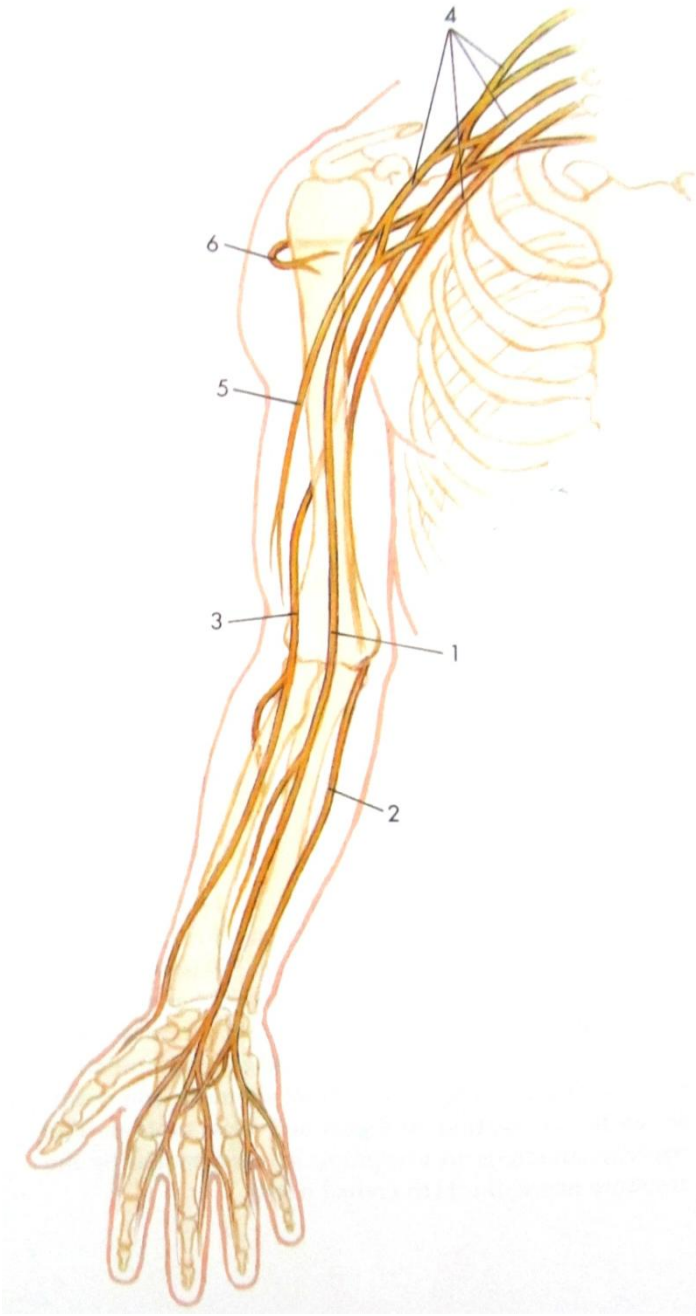
Eg; Torniquet palsy, Saturday night palsy.

Second degree: Axonal distruption occurs followed by Wallerian degeneration. Endoneurial sheaths preserved. Tinel's sign progressive, complete recovery is possible.

Third degree : Axonotmesis present. Endoneurial sheath basal laminae disrupted. Tinel sign will progress still the complete recovery will not occur.

Fourth degree: Neurotmesis with anatomic continuity. Only epineuriam intact. All sub epineurial structures damaged. Tinel's sign present not progressed. Nerve repair & grafting is must.

Fifth degree: Neurotmesis without anatomic continuity complete disruption of all the elements. No recovery is possible without repair / graft/ conduit. Penetrating trauma and stretch avulsion may be the cause.



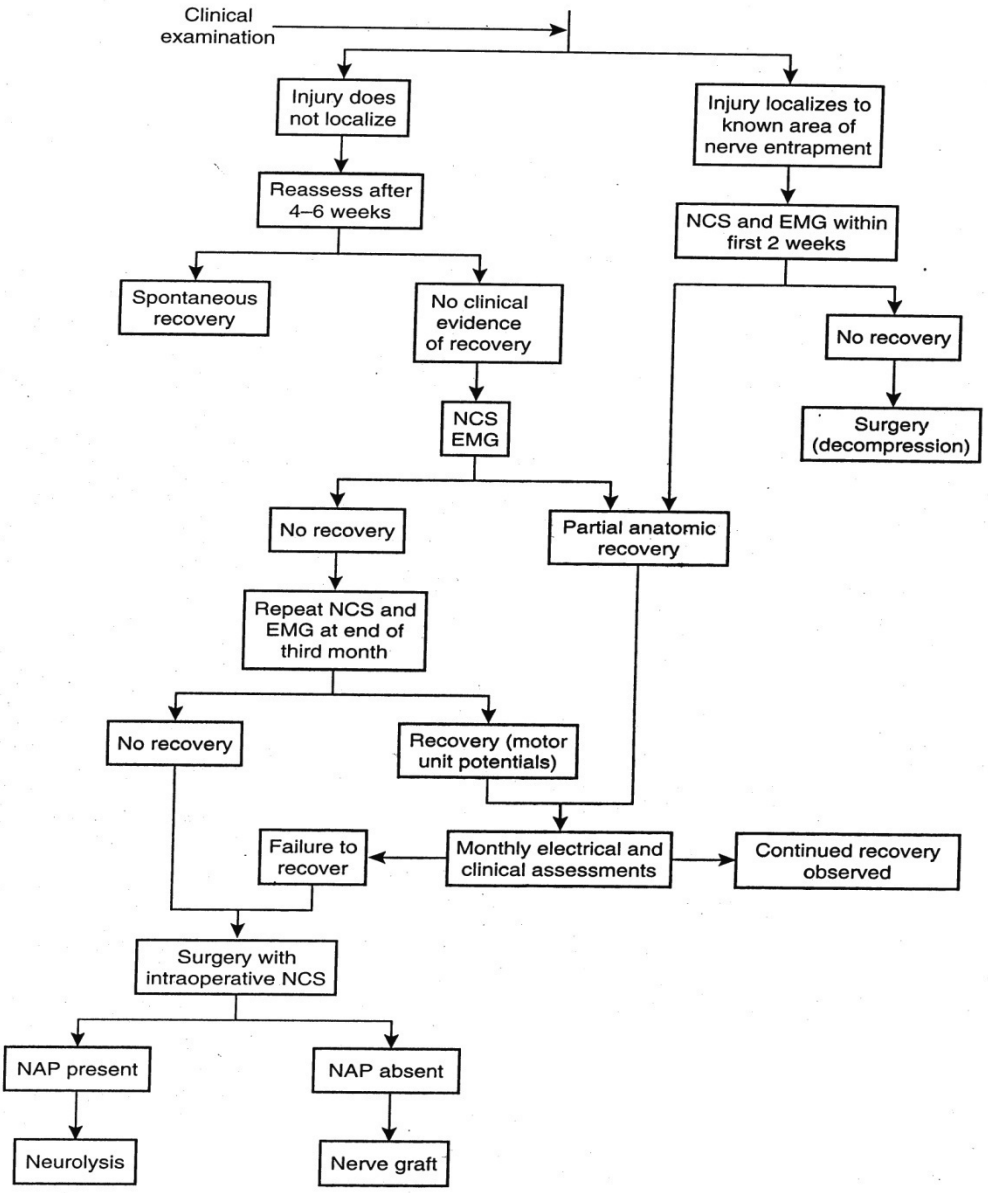
INNEVERVATION OF THE HAND AND UPPER LIMB

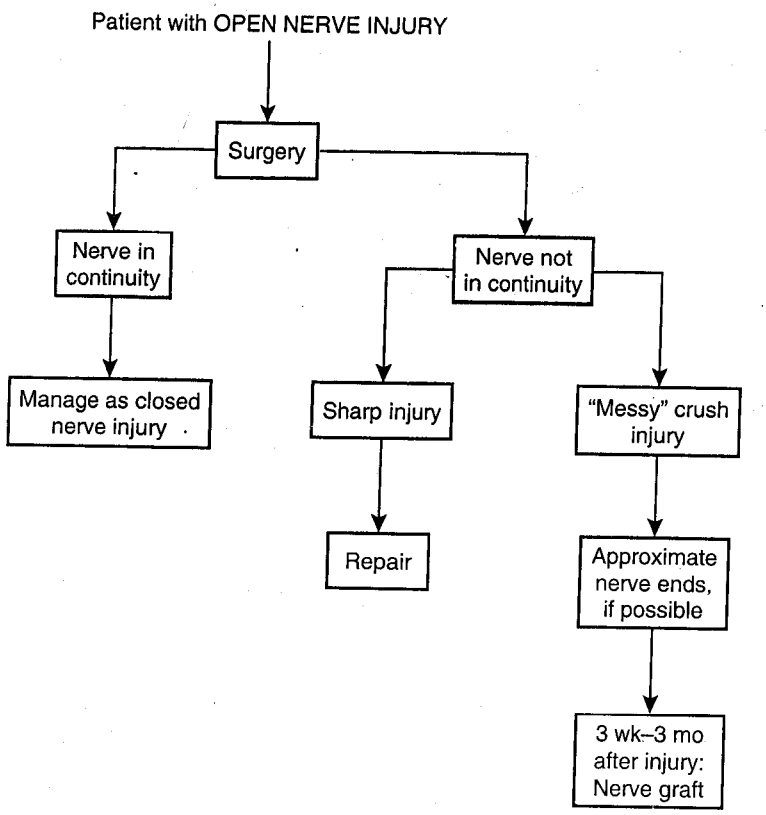
1. Median nerve
2. Ulnar nerve
3. Radial nerve
4. Brachial plexus
5. Musculocutaneous nerve
6. Axillary nerve

Sixth degree : Neuroma in continuity:

The combination of different degrees of injuries. Most challenging to treat, third degree injury may be downgraded by intervention so it differed. In IV and Vth degree needs repair / grafting. Nerve conduction study, Electro myography and MRI are the useful tools to assess the anatomical sight of injury and the degeneration of nerve fibres.

PATIENT WITH CLOSED[27] NERVE INJURY





Nerve reconstruction:-

1) Primary repair with epineurial repair.

2) Fascicular repair

Both give equally good results. Intra operatively fascicules identified by nerve conduction studies, awake stimulation, Histological staining.

NERVE GRAFTING:

Grafting done with minimal tension, if defect is more than 6 cm.

Rule of Thumb: Any tension that which can be overcome by 8'0 nylon suture is too much.

Nerve grafting: Both proximally and distally cut ends show sliding ends of fascicles. The distance is measured to assess the deficit.

Donor grafts: Medial, lateral antibrachial nerves, up to – 10 cm.

- Surall nerve upto- 40 cm
- Radial sensory nerve- 25 cm
- Saphenous nerve in the lower extremity- 40 cm
- Greater aricular nerve

Specialised grafts: Pedicled grafts Vascularised grafts – Nerve grafts along with feeding vessels

Conduits – Non neural tubes

- Silicon tubes
- Arterial conduits
- Venous conduits

ALLO GRAFTS:

Advantages – Long grafts can be obtained. Plenty of supply, lesson the donor site morbidity. Disadvantage – Costly in processing and immune reactions are common.

Nerve transfers: Here distal end of injured nerve or nerve fibre near to target organ is anastomosed with less important or other nerves. Most useful in brachial plexus injuries.

End – To – Side neurorrharphy : Distal end of the injured nerve sutured with uninjured donar nerve.

OUTCOMES IN NERVE REPAIR AND NERVE GRAFTING:

The british medical research council's rating system[27] for motor and sensory recovery

Motor Grade	Level of recovery
M0	No recovery
M1	Perceptible contraction in proximal muscles
M2	Perceptible contraction in proximal and distal muscles
M3	Contraction possible against gravity
M4	Contraction possible against resistance
M5	Full recovery in all muscles

Sensory grade	Level of Recovery
S0	No recovery
S1	Recovery of deep cutaneous sensibility
S1+	Recovery of superficial pain sensibility
S2	Recovery of superficial pain and some touch
S2+	S2 recovery with hypersensitivity
S3	Recovery of pain and touch without hypersensitivity
S3+	S3 recovery with localization and some two- point discrimination
S4	Complete recovery with normal two- point discrimination

DIGITAL NERVE REPAIR[27]:

Two – point discrimination ≥ 6mm is 17%, 6 to 10 mm in 34% reported.

Median and ulnar nerve repair:

Median nerve function 72% motor, 57% sensory. Ulnar nerve - 53% motor and 43 % sensory improvement is reported.

Nerve Grafting: higher grades of recovery in Median nerve occurs than ulnar nerves. Median nerve 93% ulnar nerve 85%.

SOFT – TISSUE RECONSTRUCTION OF THE HAND

THE LEVEL AND ANGLE OF AMPUTATION IN FINGERTIP

A. Volar oblique, skin soft tissue injury not exposing bone.
B. Volar oblique exposing bone.
C. Guillotine amputation.
D. Dorsal oblique.

Subungual Haematoma: Collection of blood underneath nail. Not necessary to intervene < 10 – 25% Evacuation 25- 50%. If > 50% nail plate to be excised.

Allow to heal by secondary intention <1cm square raw area .Skin Graft >1 cm square if bone and tendon not exposed. SSG, 2nd layer hypothenar graft, Instep grafts are the donor sites.

Local Flaps : Dorsal oblique cut V - Y advancement flap

Guillotine amputation 1) Lateral Kutler32 V-Y flap, (2) Atasoy V- Y flap, (3)Thenar flap, (4) Moberg flap for thumb.

Volar oblique: Cross finger flap, for thumb Littler's flap[23].

Regional flaps: 1.Distally based radial artery forearm flap . Vascular basis radial artery and its venae comitantes .Disadvantage is disfigurement of donor site.

2. Distally based ulnar artery flap[5]: Disadvantage is based on hand's dominant artery and disfigurement.

3. Reverse posterior interossous artery flap[3]: Vascular basis is anastomoses between anterior and posterior interossous arteries.

Distal flap : 1**.** Groin flap based on superficial circumflex iliac artery . Upto 10 cm width defect can be closed primarily. Scar in hidden area.

2. Superficial Inferior Epigastric Artery based hypogastric flap. Upto 10-12 cm width can be closed primarily.

3. Lateral Thoracic Artery[5] based axial flap thin and pliable. It suits well to ambulatory patients unsighty scar is disadvantage.

Random flaps: 1.The abdominal flap, both superiorly and inferiorly based . The length to width ratio is 1.5:1.

2. Medial surface contralateral arm flap superiorly based. Length to width ratio 2 : 1.

Free flap: Advantage to transfer bone nerve and tendons along with tissue cover .

1. Faciocutaneous lateral arm flap based on posterior radialcollateral artery,branch of profundi brachial artery . Triceps tendon and segment of humerus bone,lateral cutaneous nerve of the arm
2. The temporoparietal fascia free flap based on superficially temporal artery. The donor site is closed primarily.

   Other flaps are the scapular flap, groin flap, dorsalis pedis flap, latissimus, serratus anterior,and rectus abdominus can be used.

MATERIALS AND METHODS

The study was a descriptive study conducted in the Department of Plastic and Reconstructive Surgery of Thanjavur Medical College from October – 2009 to February– 2012. The patients were assessed clinically and included in the study.

INCLUSION CRITERIA:

All patients with injuries of both hands and forearm related to Agricultural related works.

EXCLUSION CRITERIA:

Patients with road traffic accidents, Assault, and non agricultural related industrial injuries ruled out. Patients associated with other major, abdominal, head injuries, leg injuries, cardiothoracic injuries ruled out. All the patients to the study criteria were admitted in Trauma wing. They were received first aid and then referred to Plastic Surgery Department.

Detailed history was taken on the mode of injury, time of injury, time since injury and Hospital admission. Then all the patients were subjected to average general examination and local examination to assess the nature of injury and the need for surgical intervention. The nature of injury includes skin, soft tissue laceration / loss, tendon injury, nerve injury & vascular injury, bony injury and also the viability of the distal part, wound contamination. Laboratory investigations , Hb, urine - albumin sugar, BT.CT., blood sugar, urea, creatinine ECG, X- Ray of hand and chest taken . Doppler study,in suspected cases of vascular injury, was done.

Patients were taken to emergency operation Theatre and wound wash , wound debridement done under anesthesia. (Digital block, wrist block Axillary block, supraclavicular block, GA). Fractures were fixed with Axial / cross K wire /POP splint. Post operatively limb elevation done and suplimented with antibiotics and analgesics. Other soft tissue repairs done according to the nature of injury.

From infected wound, pus taken and sent for Culture and sensitivity. Patients treated according to results. Daily saline dressing done. Patients evaluated on alternative days, till discharge. Sutures removed on 10^{th} postoperative day. Follow up visits on every Friday in our hand clinic, if needed in - between. We had Physiotherapists, to take care of our patient and to improve the functional outcome. There is also an artificial limb centre to meet out the basic needs of our patients.

Patients evaluated with parameters, wound healing, wound infection, functional deficit, / return to work / psychological satisfaction. Scores given for

Functional Improvements - 2 points

Return to work - 2 points

Aesthetical appeal - 2 points

5 - 6 good results, 3 - 4 satisfactory, < 3 poor results.

Data's collected, analyzed statistically and results obtained, conclusions derived from the results.

RESULTS

In this study of Agricultural hand injuries 89 cases were studied at the department of Plastic and reconstructive Surgery in Thanjavur Medical College. Between October-2009 to February -2012.

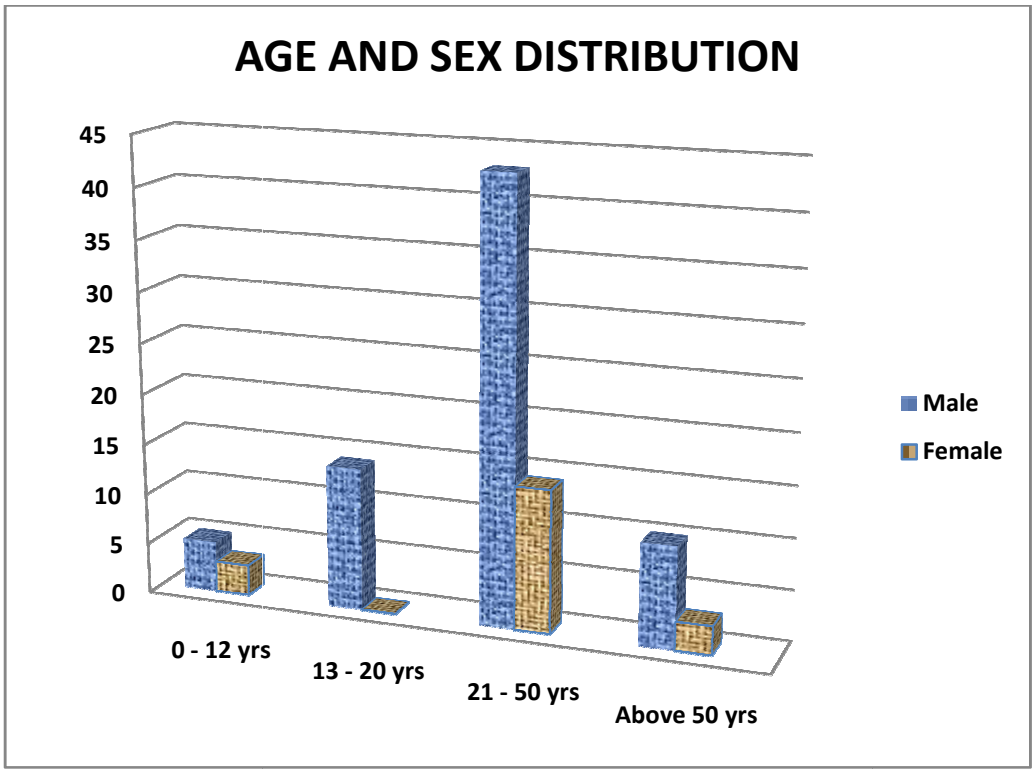
HAND INJURIES

NO.OF HAND INJURIES	NO. OF AGRICULTURAL HAND INJURIES	PERCENTAGE
955	89	9.31%

AGE AND SEX DISTRIBUTION OF STUDY POPPULATION

S.NO	AGE IN YEAR	NO.OF CASES		TOTAL	PERCENTAGE
		MALE	FEMALE		
1.	0 - 12	5	3	8	09%
2.	13 – 20	14	-	14	15.7%
3.	21 - 50	43	14	57	63.8%
4.	Above 50	10	-	10	11.3%

The age of the injured patients ranged from 4years to 65years. In this study 9% belongs to pediatric age group, 15.7% belongs to adolescent group, 63.8% belongs to adult population,11.3% belongs to elder group.



SEX DISTRIBUTION

Males injured -72, Females injured - 17

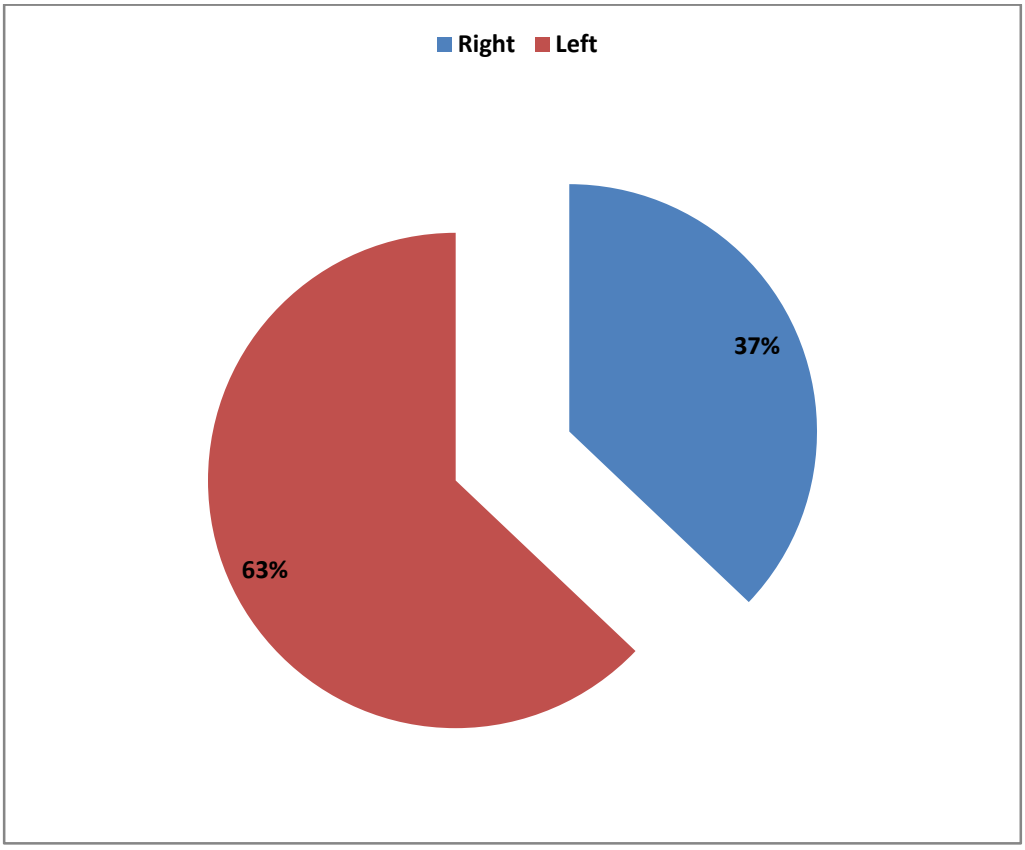
Male to female ratio is **4.2 : 1**

HANDEDNESS

Right handed individuals injured- 88 cases

Left handed individuals injured- 1.

INJURIES IN HAND - SIDE



Right hand injuries - 32, Left hand injuries 57.

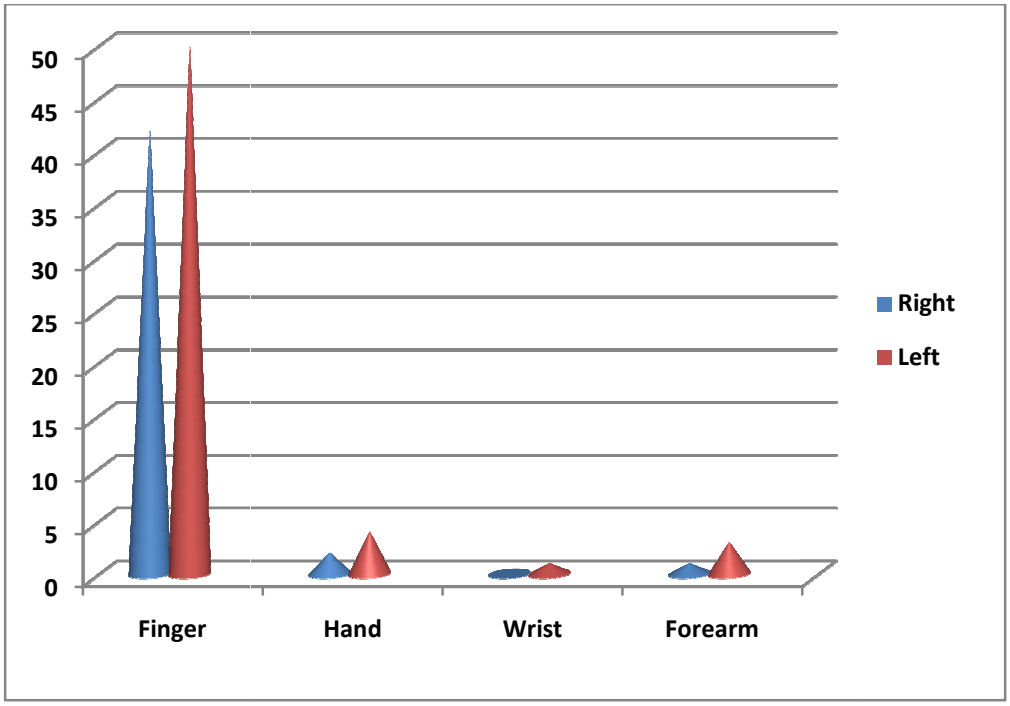
Most of the patients are right handed individuals so the cut injuries are more commonly presented in Left side and the machinery injuries mostly on right side.

Right Handed injuries are contribute to 37% and Left Handed injuries contribute to 63%.

PATTERN OF INJURIES

S.NO	SITE OF INJURY	NO OF CASES	
		Right	Left
1.	Finger	42	50
2.	Hand	02	04
3.	wrist	-	01
4.	Forearm	01	02

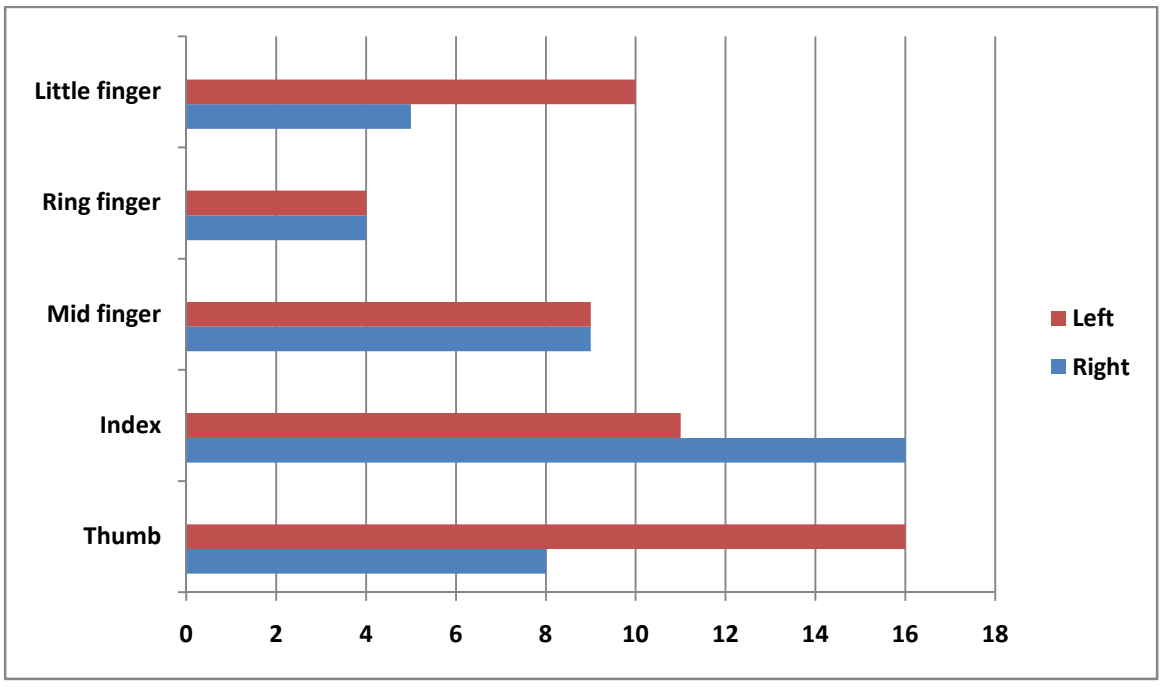
Ninety two finger injuries out of all injuries.



Finger injuries are most common type of injury about 90% of total agricultural injuries. Among them left sided injuries are more common than Right sided injuries.

PATTERN OF INJURIES IN FINGERS

S.NO	FINGERS	RIGHT	LEFT	TOTAL
1.	Thumb	8	16	24
2.	Index	16	11	27
3.	Mid finger	9	9	18
4.	Ring finger	4	4	8
5.	Little finger	5	10	15



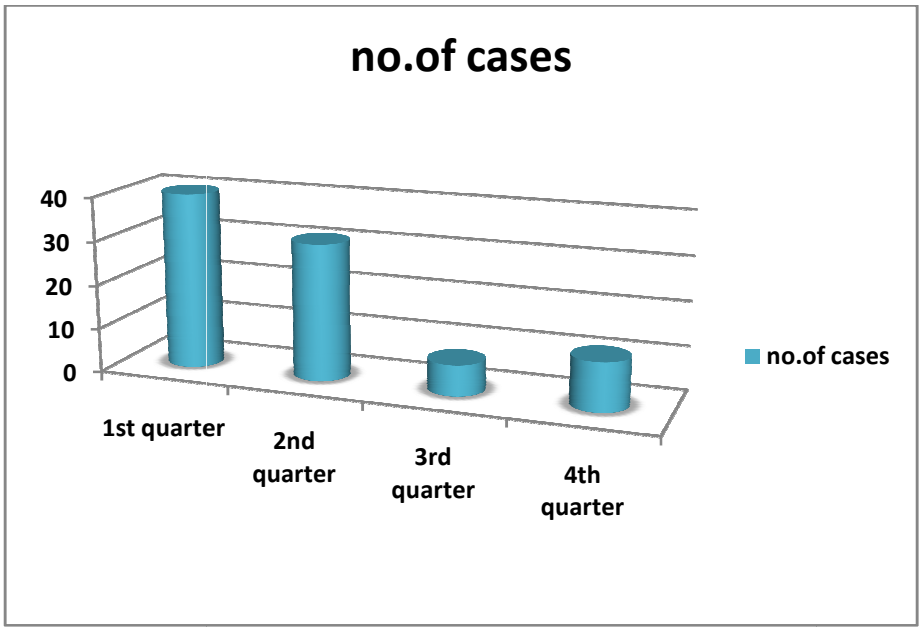
Most of the injuries are common in prehensile sensate fingers contribute to 75 %.

(F1- 24, F2- 27 , F3- 18 total – 69).

PERIOD OF INJURY

S.NO	PERIOD OF OCCURANCE	NO OF CASES	PERCENTAGE
1.	Jan - Mar	40	44.9%
2.	Apr - Jun	31	34.8%
3.	Jul - Sep	07	07.9%
4.	Oct - Dec	11	12.3%

From Janauary to March 40 cases admitted and treated. April to June 31 cases admitted and treated. Out of 89 caes 71 cases admitted inJanaury to June.



Maximum No of cases recorded in 1st quarter of year corresponds to peak harvest period and next peak occurs in 2nd quarter of the year which corresponds to summer vacation .

MODE OF INJURY

S.NO	TYPE OF CUT TOOLS	NO. OF CASES
1.	Tender coconut cut	18
2.	Sugarcane cut	07
3.	Paddy harvest	06
4.	Banana cut	04
5.	Palm cut	10
6.	Wood cut	13

Cut injuries are more common with palm fruit, and tender coconut cutting They had seasonal variation with peak in summer. Wood cutting second most common 13/58.

S.NO	MACHINES	NO.OF CASES
1.	Paddy machine	13
2.	Sugar cane machine	04
3.	Coir machine	05
4.	Coconut powder machine	03
5.	Tractor crush	01
6.	Oil engine &hand pump	04

TIME SINCE INJURY, TO HOSPITAL ADMISSION

S.NO	TIME OF ADMISSION	NO.OF CASES
1.	Within 6 hours	25
2.	6 – 12 hours	29
3.	12 -24 hours	18
4.	More than 24 hours	17

People around Thanjavur presented early for admission. People from distant places came late. About 61 % people get admitted with in 12 hours,39% admitted after 12 hours or even more delayed.

AWARENESS IN PRESERVING AMPUTATED PARTS

Total no of amputees presented	8 persons
Packing in contaminated bags	4
Amputated parts directly within the ice bag	2
Packed in news paper	1
Properly packed in sterile container	1

Seven out of eight amputees did not know how to preserve the amputated part.

TREATMENT OPTIONS:

S.NO	MODE OF TREATMENT	NO. OF CASES
1.	Groin flap	6
2.	Hypo gastric flap	1
3.	Posterior interosseous Artery flap	1
4.	Cross finger flap	7
5.	Litter's flap	1
6.	V – Y flap	4
7.	Kutler's flap	2
8.	Moberg flap	1
9.	Primary skin Suture	10
10.	Skin graft	3
11.	K' wire fixation	22
12.	Buddy's & other splint	6
13.	Tendon repair	14
14.	Repositioning	5
15.	Vascular repair	1
16.	Nerve repair	3
17.	Shortening closure	10
18.	Major amputation	1

Various flaps had done in 23 patients, 'K' wire fixation done in 22 patients, tendon repair in 14 patients, 10 underwent minor amputation, 1 had major amputation.

POST OPERATIVE COMPLICATIONS;

S. NO	COMPLICATIONS	N.OF CASES
1.	Edema	10
2.	Wound infection	12
3.	Skin Necrosis	7
4.	Suture dehiscence	5
5.	Partial flap necrosis	2
6.	Stiffness in hand &finger	9

MICROBIOLOGICAL SCREENING:

In 22 cases, we have done pus culture and sensitivity . Results are as follows.

S. NO	**ORGANISM**	**POSITIVE IN CULTURE**	**SENSITIVITY**
1.	Staph.aureus	14 cases	Cefotaxime, Ceftriaxone, Erythromycin, Doxycycline
2.	Pseudomonas	04 cases	Gentamicin, Ceftriaxone
3.	Klebsiella	03 cases	Amikacin
4.	No organism present	01 cases	–

Staph. aureus present in 63.6% of culture and pseudomonas present in 18.2% of culture both contribute to 81.8% in total. Both are sensitive to Ceftriaxone

RETURN TO WORK

S.NO	DURATION	NO. OF CASES	PERCENTAGE
1.	3 -6 weeks	32	35.9%
2.	7 – 10 weeks	24	26.9%
3.	11 – 14 weeks	23	25.8%
4.	15 weeks and above	10	11.2%

About 88.8% of patients return to work between $3\frac{1}{2}$ to 4 months .The remaining 11.2 % of people those who having multiple fractures and wound infection, joint stiffness and secondary procedures needed prolonged time to recover.

DISCUSSION

Peadiatric population of 0 – 12 years age group is about 9%of total agricultural injuries. This is mainly because of permitting the children[33] to the farm and inadequate supervision of children while working. Most of injuries occur in persons having the productive potential in the age group of 20 – 50 years. This causes the significant loss of income. Males are most affected than females. Male to Female ratio is about 4.2 : 1

Most of the people are Right handed individuals, so the cut injuries are common in Left hand side. The machinery crush injuries are common in Right hand side.

The incidence of injuries are more common in January – March (1st quarter) of the year (45%).This corresponds to the peak of the harvest season of paddy. The sugarcane harvest and consumption is more at the time of Pongal festival in January. The second peak in incidence is seen in April – May (34.8%). This is the period of summer vacation of schools and colleges. Children are free to move around. Tender coconut, palmfruit, Banana harvest and consumption is high in this period.

People near to medical college, around Thanjavur town get admitted early. People from adjacent districts and far places of our district are presented to the hospital late because lack of transport facility . Recently 108 free Ambulance service started by Tamil Nadu Government. It is very much useful in reducing the time of transport and cost. They are accompanied with trained person is an added advantage.

Awareness in preserving amputated limbs is poor, even though the people aware the amputated part can be reimplanted. The knowledge and method of preservation is lacking.

In our study population fatal injuries[1] are rare. In developed countries agro based machineries and tractors are common. So the incidence of agro related fatal injuries are significant.

Thumb, index, midfinger are most commonly affected. Various finger fractures contributes to the significant number of disability. Both cut injuries and crush machinery injuries contributes in minor amputations. For major amputations machinery injury is the cause.

Wood cutting injuries present throughout the year. Tender coconut and palm cutting injuries are peak in the 2nd quarter (summer vacation). Most of the cases had thumb and finger injuries with or without fracture.

Machinery injuries contribute 34.8 % of total agricultural hand injuries. Most of the injuries associated with, fracture of finger and hand. Multiple finger injuries seen in machinery crush injury.

The treatment modality is selected according to the nature of injuries. Most of the fractures are fixed with ‘K’ wire and immobilized with POP. Comminuted fractures, those are not able to fixed with ‘K‘wire, are managed by Buddy’s splint and molding POP. The complications are mostly related with machinery injuries. They are managed by Limb elevation, wound debridement, sensitive antibiotics, Re suturing and physiotherapy.

Most common organism present in agriculture related hand injuries are wound infection with Staph aureus. Sensitive[15] to Cefotaxime and Ceftriaxone and erythromycin. Second most common is pseudomonas, sensitive to Ceftriaxone, Amikacin.

Patients had major amputation, flap necrosis, major crush injuries with multiple fractures, and those who needed secondary procedures taken prolonged time to recover.

Preventive measures:

Children are unnoticed during vacation time. They play with sharp weapons with their peer groups, so chances of injuries are more. Children should play under the supervision of elders and keep away from working area . Children, the age of 3 - 5 years should send to the Anganvadi center regularly.

Injuries are more common at the time of harvest, local festival time, and in summer season. Awareness camps[30] before harvest season to the target population regarding prevention, wearing protective gloves[19], comfortable tight fitted dresses, careful handling of sharp equipments, proper way of operating machineries should be conducted.

If injury occurs, how to clean the wound, getting tetanus immunization, advice to go nearby primary Health Center or any health units for first aid, Preservation of amputated parts, details about Government 108 ambulance service and private services, the importance of early admission to hospital should be taught to health workers and target population.

The companies should plan to design machineries to reduce the accident. The machines should fully molded and small doors are fixed, where necessary for operating. The high power machines[1] cause severe injuries to the workers, so power should be standardized. The company should properly train the buyers about machineries.

Policy makers[30] should arrange adequate funds to ensure the poor people safety and to strengthen the health sector and also to improve the transport facilities.

CONCLUSIONS

- Agricultural hand injuries are serious problems in rural societies of developing countries
- Our study is based only on hospital reported cases. If other private hospital cases are added, it may contribute to significant hike in this problem.
- Minor injuries are underreported in hospital studies as compared to population based health studies.
- The injuries are more common in the age group of 20-50 years. They are doubly handicapped, most of them not trained for any other work and results in a greater economic loss to the family and society.
- Children and old age group people also constitute a significant proportion of the farm work force. Home and work place environments overlap in farming making children vulnerable to injuries. No serious attempt has been identified to include consideration of the presence of children and older people as a factor in safer design of farm machines.
- Hand tool related injuries are a problem seen commonly in the study group. Farm injury patterns are severe in the machines causing injuries. Paddy and coconut are the main crops in this district so the agro industrial injuries based on these two crops are common.

- Awareness and knowledge of people regarding hand injuries and its prevention is lacking. Proper health education and health campaigns to achieve behavioural modification will prevent significant number of injuries.
- Equipments operating at higher energy levels appears to be associated with incidence of more severe injuries. Such equipments need more attention for incorporating safer design.

COMMON SHARP HAND TOOLS

MODE OF INJURY

PADDY THRASHER

RICE POLISHING MACHINE

GROUNDNUT THRASHER

RICE POLISHING MACHINE

OIL SEED GRINDER

COCOUNUT CRUSHER

COIR MACHINERY

COIR MACHINE

SUGAR CANE JUICE MACHINE

DIESEL MACHINE

TRACTOR

LEFT F5 FINGER TIP INJURY

PRIMARY REPAIR

LEFT THUMB INJURY

SPLIT SKIN GRAFT

RIGHT F3 FINGER TIP INJURY

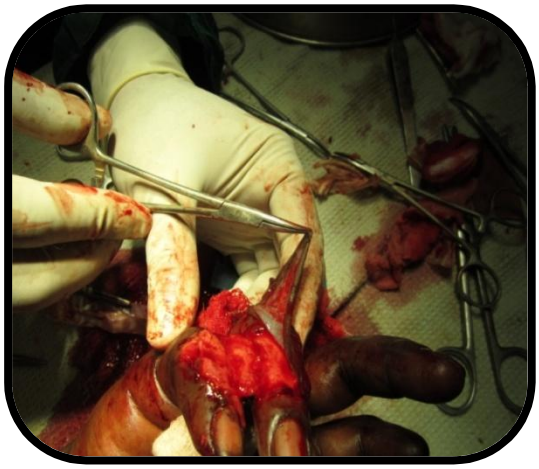
V-Y-FLAP

RIGHT F2 FINGER TIP INJURY

CROSS FINGER FLAP

RIGHT F5 DORSAL LACERATION

DE EPITHELISED CROSS FINGER FLAP



LEFT THUMB CRUSH INJURY

PRIMARY TENDON REPAIR

LEFT THUMB EPL INJURY

EPL REPAIR

LEFT F5 CRUSH INJURY

SHORTENING CLOSURE

LEFT THUMB CUT INJURY

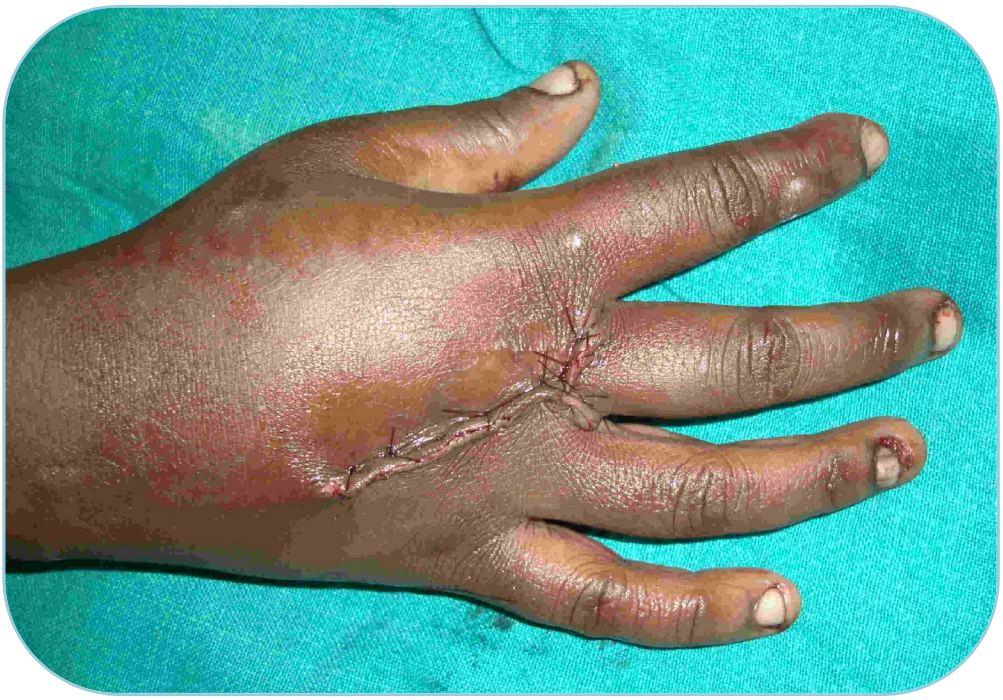
PPX FRACTURE

AXIAL 'K' WIRE FIXATION

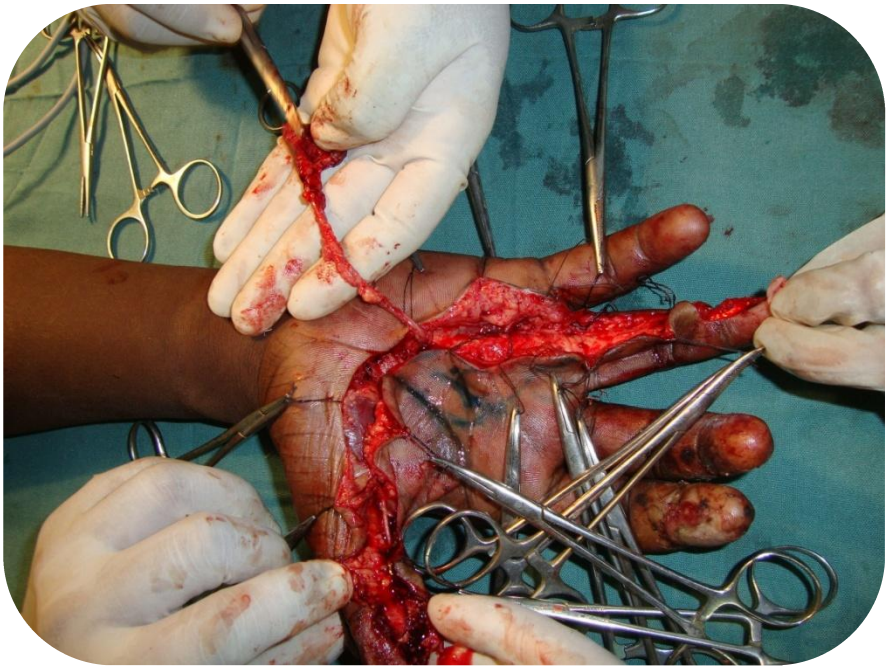
RIGHT HAND DORSAL INJURY

FRACTURE THIRD METACARPAL

‘K’ WIRE FIXATION



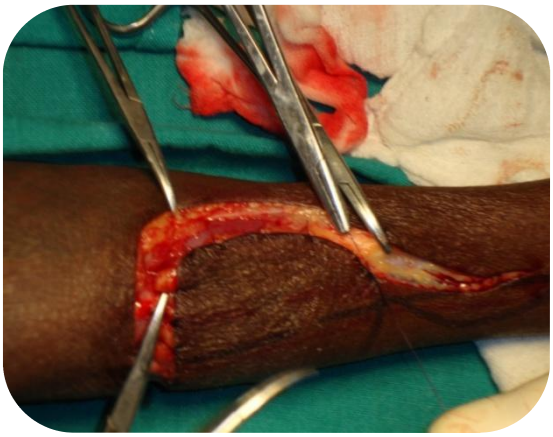
RIGHT THUMB PULP LOSS



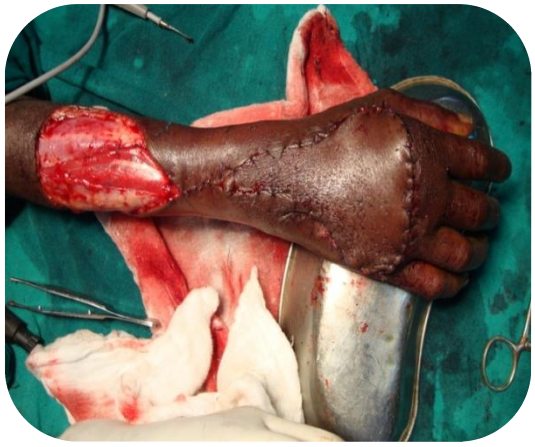
LITTLER'S NEURO VASCULAR FLAP

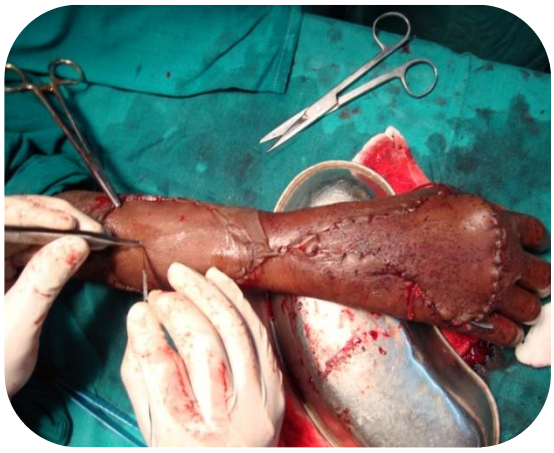
SUGAR CANE MACHINE CRUSH INJURY

RIGHT HAND DORSAM RAW AREA



REVERSE POSTERIOR INTEROSSEOUS FLAP

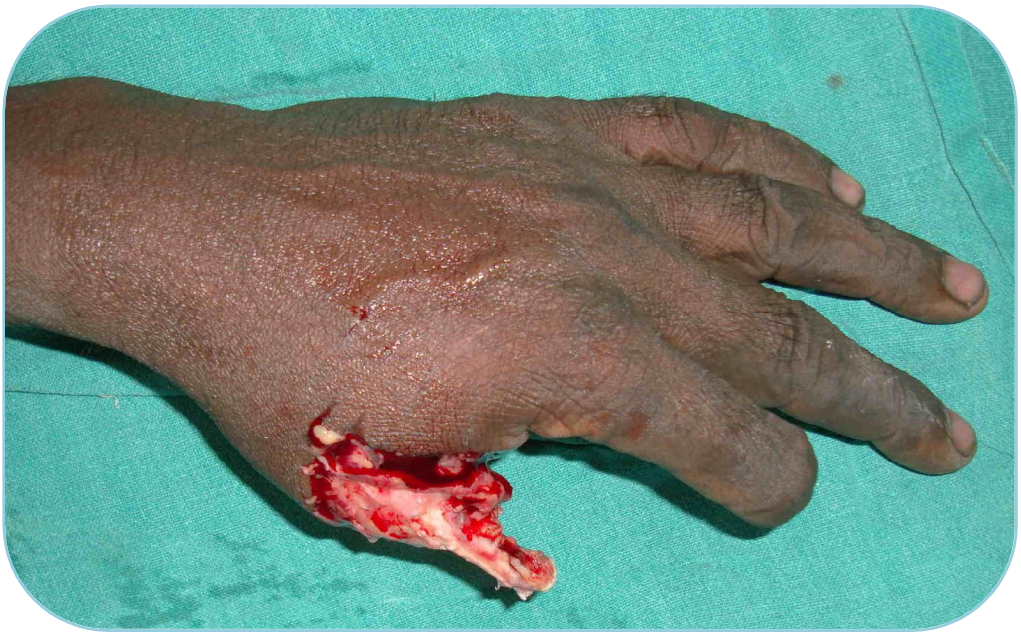




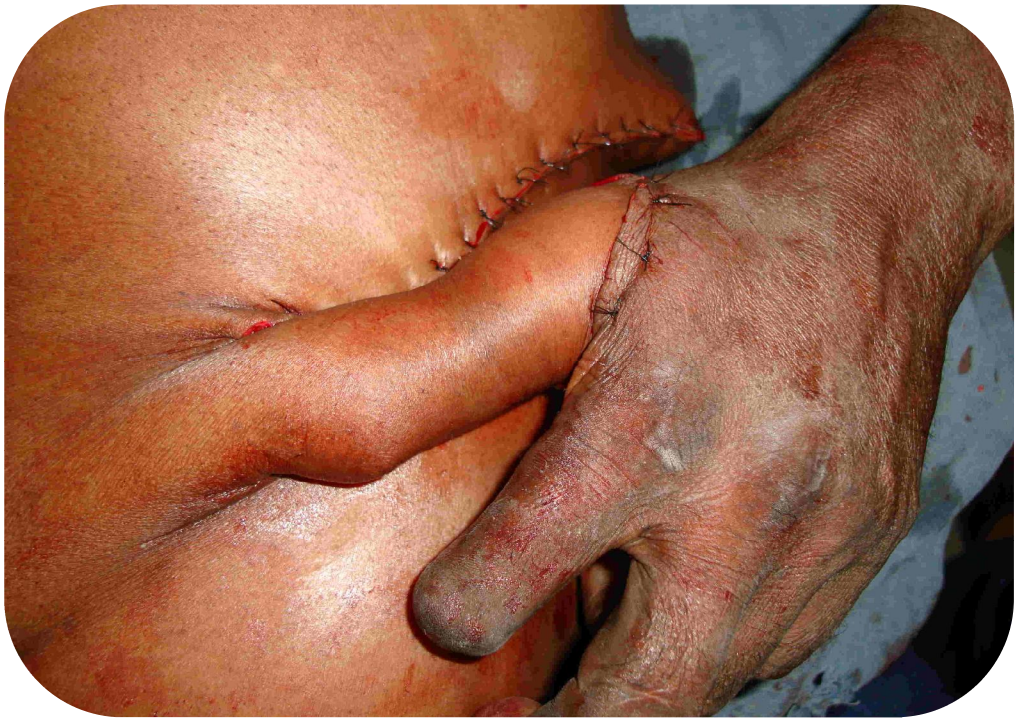
RIGHT DORSAM INJURY

HYPO GASTRIC FLAP

LEFT THUMB CRUSH AVULSION INJURY



GROIN FLAP



DEPARTMENT OF PLASTIC & RECONSTRUCTIVE SURGERY

THANJAVUR MEDICAL COLLEGE, THANJAVUR

AGRICULTURAL RELATED HAND INJURIES

A STUDY 2009 - 2012

PROFORMA

NAME :

AGE : SEX : I.P.NO :

ADDRESS :

OCCUPATION :

HANDEDNESS :

SOCIOECONAMIC STATUS :

NO OF DEPANDANTS :

MODE OF INJURY :

NATURE OF INJURY : CUT/ CRUSH/ CRUSH AVULSION/ AVULSION/ BLUNT

ANATOMICAL SITE OF INJURY :

RIGHT LEFT

ZONE OF INJURY : FLEXOR EXTENSOR

F1

F2

F3

F4

F5

BONY INJURY :

NEURO VASCULAR INJURY :

INVESTIGATIONS :

TREATMENT :

COMPLICATIONS :

PHYSIOTHERAPY :

FOLLOW UP :

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MASTER CHART

S. NO	NAME	AGE	SEX	IP NUMBER	MONTH	MODE OF INJURY	DIAGNOSIS	TREATMENT	COMPLICATION	RETURN TO WORK	GRADING
1.	Marriappan	28	M	1209576	1	M1	Lt F2, F3,F4,F5 at MC level	18	2,6	4	1
2.	Raj kumar	17	M	1300348	1	C1	DPX # in Rt F2,F3 with zone 1 extensor injury	11	-	3	2
3.	Rayappan	30	M	1300678	1	M1	Lt F1,F2,F3 crush injury dislocation of LI ,II, III MC level	13	3,2,6	4	2
4.	Vanasundari	40	F	1301321	1	C2	Dislocation of Lt thumb MCP joint.	11	1	2	5
5.	Balasubramaniyam	36	M	1302172	1	M1	Zone I,III extensor injury, Rt thumb mallet finger deformity	11,13	2	2	2
6.	Durairaj	42	M	1302246	1	M6	Lt F3, # dpx	11	-	2	5
7.	Sumathy	29	F	1302609	1	C2	Lt F5, # DPX	11,	-	2	3
8.	Chandraleka	26	F	1303826	1	C1	Rt Index, Partial amputation / PIP Level	17	-	1	4
9.	Thurai murugan	13	M	1303726	1	C2	Lt F5, finger tip injury	17	2	1	4
10.	Silambarasan	25	M	1304018	1	C3	Rt F2, # MPX, Zone II extensor	11,13	1	3	3
11.	Adimuthu	55	M	1304132	1	M1	Lt F5, # MPX, PPX,	17	3,6	3	3
12.	Nandini	4	F	1304266	2	C6	Lt thumb fingertip injury	6	-	1	4
13.	Thaludeen	50	M	1305171	2	M1	Lt F3, MPX #	17	-	1	3
14.	Loganathan	47	M	1313924	4	M2	Lt Thumb amputation DIP Joint	17	-	1	4
15.	Palanipanikar	45	M	1312101	4	M2	Lt F4, # MPX, F5DPX # with pulp laceration	9	1	3	2
16.	Selvam	35	M	1080356	4	C1	Lt Zone V flexor injury, ulnar nerve FDS, FDP IV,V	16,13,15	3	4	3
17.	Venkatesan	33	M	1306195	2	M6	Rt F2, Zone III extensor injury F3,F4 PPX #	11,13	-	4	3
18.	Marimuthu	55	M	1307242	2	M1	Rt F2, # MPX,PPX,	9,12	6	3	2

MASTER CHART

S. NO	NAME	AGE	SEX	IP NUMBER	MONTH	MODE OF INJURY	DIAGNOSIS	TREATMENT	COMPLICATION	RETURN TO WORK	GRADING
19.	Rajendran	60	M	1307530	2	M3	Lt Thumb, partial amputation,# DPX	17	-	1	4
20.	Balasubramaniyan	7	M	1308583	2	M1	Rt F3, fingertip injury	6	-	1	5
21.	Rajakilee	50	F	1309043	3	C6	Lt F5, fingertip injury	7	-	1	4
22.	Santhosh	8	M	1353629	11	C1	Rt thumb partial Amputation Base of PPX	1	4	3	4
23.	Bernandas	55	M	1313661	3	M2	Rt F2,# DPX	17	-	1	4
24.	Natarajan	33	M	1311618	3	C1	Lt Side Zone-V Flexor injury	13	-	3	4
25.	Sethu	65	M	1322520	5	C3	Lt 1st web laceration	9	2	1	6
26.	Arokyasamy	25	M	1213213	4	C5	Lt F2 ,#DPX, Finger Tip Injury	4	-	1	4
27.	Dinesh	14	M	1324012	4	C5	Lt F2, # DPX Base	9,11	-	2	3
28.	Murugaiyan	40	M	1318604	6	C4	Lt F2, #DPX Base	11	-	2	4
29.	Selvam	35	M	1324195	5	M6	Rt F3,#DPX Partial Amputation	17	-	1	4
30.	Kannayan	60	M	1322353	5	C5	Lt F2, Fingertip injury	14	-	2	3
31.	Ramu	32	M	1322052	5	C6	Rt thumb Zone III extensor injury	13	6	2	5
32.	Marimuthu	55	M	1348020	11	CB	Cracker Burst Injury, Lt thumb Avulsion Injury	1	5	4	4
33.	Karupaiyan	58	M	13217360	5	C1	Lt Zone VII extensor injury ECRL, ECRB	13	4	3	5
34.	Chinnan	50	M	13211199	5	M2	Rt F2, # MPX	12	1	2	3
35.	Vigneshwaran	15	M	13212342	5	C5	Lt F1, fingertip injury	4	-	1	4
36.	Saraswathy	25	F	1320317	5	C4	Lt F2, DIP, partial amputation	14	-	2	3

MASTER CHART

S. NO	NAME	AGE	SEX	IP NUMBER	MONTH	MODE OF INJURY	DIAGNOSIS	TREATMENT	COMPLICATION	RETURN TO WORK	GRADING
37.	Vipin	17	M	1321343	5	C5	Lt thumb, # PPX,EPL injury	11,13	1	3	4
38.	Susi	12	F	1321642	7	C6	Lt F2, partial amputation	17	-	1	4
39.	Murugesan	40	M	1300353	3	M1	Lt F3,# PPX	9,12	-	4	3
40.	Preamanandan	30	M	1074972	3	C6	Lt F2,F3 # MPX	9,11	2	3	3
41.	Kalaiselvan	16	M	1335668	2	C1	Lt Thumb Partial Amputation Base PPX	1	-	3	4
42.	Madhanraj	9	M	1314070	4	C5	Rt F5 DIP # Dislocation	11	-	2	4
43.	Dinesh	13	M	1371011	4	M1	Lt F2 DPX Injury	9	2	1	5
44.	Selvi	29	F	1320317	5	C1	Lt F2 DIP Level Injury	14	-	3	2
45.	Pradeep	14	M	1324136	5	C5	RT F3 F4 F5 Zone-I Flexor Injury	13	3	2	4
46.	Aneeshkan	15	M	1369850	2	C2	Lt F2 DIP Level Injury	11	-	2	4
47.	Saravanan	16	M	1363314	2	C6	Lt Thumb Fingertip Injury	4	-	1	4
48.	Lalitha	26	F	1367250	2	M5	Rt F2 # MPX, PIP Level Injury	17	1	2	2
49.	Ganesan	24	M	1366264	2	M1	Rt F2 Fingertip Injury	4	-	1	3
50.	Ambigapathy	47	M	1365181	1	C1	Lt Thumb EPL Injury, # PPX	11, 13	1	2	3
51.	Ponnima	34	F	1363980	1	C6	Rt F5 Partial Amputation MPX Level	17	4	1	4
52.	Anjammal	35	F	1362347	1	M4	Rt F2, F3, F4, F5 MC #	11	3, 6	4	2
53.	Ramesh	26	M	1361864	1	C2	Lt Thumb EPL Injury, Zone-II	13	-	2	5
54.	Shakthivel	30	M	1338238	8	C6	Lt F3 MPX Injury	11	-	3	3

MASTER CHART

S. NO	NAME	AGE	SEX	IP NUMBER	MONTH	MODE OF INJURY	DIAGNOSIS	TREATMENT	COMPLICATION	RETURN TO WORK	GRADING
55.	Nithiesh	14	M	1340442	9	C1	Rt F2, PPX # F3 Zone IV Extensor Injury	11, 13	2, 6	3	3
56.	Vishal	10	M	1351201	9	C4	Lt Thumb Partial Amputation PPX	10	-	1	5
57.	Virapillai	27	M	1351512	11	C6	Lt F2, # DPX, Base	11	-	2	4
58.	Kamalananth	22	M	1352372	11	C1	Lt F2 # DPX	11	2	3	4
59.	Natarajan	38	M	1353504	11	C3	Lt F2 Finger Tip Injury , # DPX	4	-	1	4
60.	Ponnammal	45	F	1354102	12	M1	F4, Partial Amputation, DPX #	9	-	3	4
61.	Sasikumar	35	M	1324737	6	C1	Lt Zone V Flexor Injury	16	3	2	4
62.	Ramaiyan	63	M	13205029	6	M3	Rt Thumb Partial Amputation	4	-	1	4
63.	Sekar	40	M	13278064	6	C5	Lt F5 # DPX Finger Tip Injury	7	-	1	5
64.	Vadivel	28	M	1328692	6	C6	Lt F3, # DPX Zone-I Extensor Injury	11,13	-	3	3
65.	Shanthi	30	M	133223	7	C1	Lt Thumb Fingertip Injury	6	-	1	4
66.	Kumar	18	M	1335746	8	C1	Lt F2 # PPX Zone-IV Extensor Injury	11, 13	1, 2	4	2
67.	Duraimanickam	23	M	1337746	8	M4	Rt F2, F3 Fingertip Injury	4,9	-	1	4
68.	Manikandan	28	M	1314167	4	M1	Lt F2, F3 Fingertip Injury	6	2	1	3
69.	Paneerselvam	50	M	1314294	4	M3	Rt Zone-VI Extensor Injury	3	-	2	4
70.	Mohanraj	9	M	1314070	4	C5	Rt F3, Partial Amputation	11	6	3	3
71.	Kaleeswari	22	F	1064971	1	C3	Lt F5 # DPX	17	-	1	4
72.	Ganesan	52	M	1064973	1	C6	Lt F3 # PPX	11	-	3	2

MASTER CHART

S. NO	NAME	AGE	SEX	IP NUMBER	MONTH	MODE OF INJURY	DIAGNOSIS	TREATMENT	COMPLIC ATION	RETURN TO WORK	GRADING
73.	Muthuraman	34	M	1065522	1	C3	Rt F4, F5, Injury, # DPX F4	17, 10	1	1	4
74.	Moovendan	20	M	1066067	1	C1	Lt F2, DIP Injury	17	-	1	3
75.	Rajasekar	29	M	1066162	1	C2	Lt Thumb, Zone-II EPL Injury	13	-	2	4
76.	Manickam	42	M	1067021	1	C6	Lt F3, Zone-II Flexor Injury	11, 13	1	3	4
77.	Boominathan	29	M	1070803	2	C4	Zone-V, Rt Forearm cut Injury	9	3	1	5
78.	Aarthi	4	F	1069573	2	C2	Lt F3, Partial Amputation	14	-	2	3
79.	Rangarajan	35	M	1071930	2	C3	Lt Zone-V, Flexor Injury	15, 16	4	3	4
80.	Puspanathan	26	M	1074972	3	M1	Lt F3, F4, # DPX	9	2	4	3
81.	Muthurani	35	F	107721	4	C5	Lt F2, # MC	11, 13	6	2	4
82.	Saravanan	33	M	1353204	10	M4	Rt F5, MPX Injury	4	-	3	3
83.	Sankar	35	M	1356112	12	M3	Rt hand Dorsam Raw Area	2	4	2	4
84.	Rakkappan	29	M	1358626	12	M6	Lt thumb Partial Amputation, PPX Level	1	-	3	4
85.	Kumar	30	M	1351443	12	C6	Rt thumb partial Amputation, PPX Level	1	5	4	2
86.	Vijayalakshmi	35	F	1321780	5	C1	Lt thumb, fingertip injury	8	-	1	4
87.	Palanimanickam	47	M	1317613	4	C1	Lt F5,DPX Shaft injury F4, MPX #	9,11	1	1	3
88.	Prabaharan	18	M	1052729	10	M3	Rt thumb Pulp Loss	5	-	2	4
89.	Sakthivel	38	M	1075579	4	M1	Rt thumb Partial Amputation PIP Level	1	-	1	5

KEY TO THE MASTER CHART

SEX	MONTH	DIAGNOSIS	RETURN TO WORK	GRADING
M – Male	1-January	Rt – Right	1 - III -VI weeks	1, 2 - Poor
F - Female	2-February	Lt – Left	2 - VII – X Weeks	3, 4 – Fair
	3-March	# - Fracture	3 - XI – XIV Weeks	5, 6 – Good
	4-April	DPX – Distal Phalanx	4 - Above – XIV Weeks	
	5-May	MPX – Middle Phalanx		
	6-June	PPX – Proximal Phalanx		
	7-July	MC – Metacarpal		
	8-August	DIP – Distal Inter Phalangeal Joint		
	9-September	PIP – Proximal Inter Phangeal Joint		
	10-October	EPL – Extensor Pollicis Longus		
	11-November	ECRL - Extensor Carpi Radialis Longus		
	12-December	ECRB – Extensor Carpi Radialis Brevis		

TREATMENT	COMPLICATIONS	MODE OF INJURY	
1 - Groin Flap	1 - Edema	C1 - Tender coconut cut	M1 - Paddy machine
2 - Hypo Gastric Flap	2 - Wound Infection	C2 - Sugarcane cut	M2 - Sugar cane machine
3 - Posterior Interosseous Artery Flap	3 - Skin Necrosis	C3 - Paddy harvest	M3 - Coir machine
4 - Cross Finger Flap	4 - Suture Dehiscence	C4 - Banana cut	M4 - Coconut powder machine
5 - Litter's Flap	5 - Partial Flap Necrosis	C5 - Palm cut	M5 - Tractor crush
6 - V – Y Flap	6 - Stiffness In Hand & Finger	C6 - Wood cut	M6 - Oil engine &hand pump
7 - Kutler's Flap			
8 - Moberg Flap			
9 - Primary Skin Suture			
10 - Skin Graft			
11 - K' Wire Fixation			
12 - Buddy's & Other Splint			
13 - Tendon Repair			
14 - Repositioning			
15 - Vascular Injury			
16 - Nerve Injury			
17 - Shortening Closure			
18 - Major Amputation			

ABSTRACT

INTRODUCTION

Thanjavur District, The Rice Bowl of Tamilnadu situated in the River Belt of Cauvery. About 8.32 Lakhs out of 24.02 Lakhs of total population are agricultural Labours. The cultivation lands available is 2.54 Lakhs hec. Paddy, Coconut, Sugar cane, Banana are the major corps. The district economy mainly depends on agriculture, about 200 agro industries running in this district. Agricultural related hand injuries are quit significant in number in the study area.

AIM

To study the pattern of injuries and epidemiological basis of Agricultural hand injuries in and around Thanjavur. To study and analyze the prognosis and recovery pattern of Agricultural hand injuries in terms of return to work following treatment. To suggest measures for prevention of injuries. Study Period – October 2009 – February 2012.

MATERIALS AND METHODS

Patients admitted with agricultural hand injuries clinically evaluated. Basic investigations done. Patients treated in emergency as well as in elective theatres. Post operative care and physiotherapy given, patients evaluated according to recovery, return to work and aesthetically. Results analyzed critically.

RESULTS AND DISCUSSION

About 89 patients had agro related hand injuries out of 955 hand injuries in the study period.

Males are mostly (72) affected than females (17). Nine percentage of them belongs to pediatric groups, 15.7 % to adolescents, 11.3 % to elderly.

In Right hand – 32, Left-hand – 57 injuries, recorded. Finger injuries are more common (90%) 71 out of 89 cases admitted in January to June related to harvest season and summer vacation

Cut injuries in 58 patients and 30 had machinery injury. About 61% of people admitted within 12 hours, others admitted after 12 hours and even later. Seven out of 8 amputees did not preserve the amputated part properly. Various flaps done in 23 patients, 'K' wire fixation done in 22, Minor amputation in 10, Major amputation in 1 person had done. Wound infection, stiffness in hand and finger are most common complications. Staph.aureus is most commonly seen in wound infection sensitive to cefotaxime, ceftriaxone.

About 88.2% return to work within 14 weeks after injury. Others with major amputation, and those who need multiple procedures, needed longer time to recover.

CONCLUSION

Children and old age people also injured in considerable (20.3%) percentage. They should be protected from the work place and machineries. The injury to the age group of 20 to 50 years contribute about 61% of cases. This results in heavy economic loss to the Family and Society. Awareness camps before harvest and summer season may prevent significant number of injuries. Policy makers should improve the transport and health facilities. Making safer designs of machines and proper training to the users prevent injuries considerably.

Keywords: Agrarian Population, Agro industry, Klinert's splint, Protective gloves, Highs energy machinery, Policy makers.